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REPORT OF THE CHIEF OF THE BUREAU OF
ENTOMOLOGY AND PLANT QUARANTINE, 1942

UNITED STATES DEPARTMENT OF AGRICULTURE,
AGRICULTURAL RESEARCH ADMINISTRATION,
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE,
Washington, D. C., September 10, 1942.

HON. CLAUDE R. WICKARD,
Secretary of Agriculture.

DEAR MR. SECRETARY: I submit herewith a report of the activities of the Bureau of Entomology and Plant Quarantine for the fiscal year ended June 30, 1942.

Sincerely yours,

P. N. ANNAND, *Chief.*

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INTRODUCTION

The war has brought important changes in many activities of the Bureau. In the research work emphasis has been put on the develop- ment of insecticides that may be used as substitutes for chemicals for which priorities have been established. Work that can be deferred has given way to work connected with the needs and problems arising out of the emergency. The control and quarantine activities have also been modified. As might be expected, the work of the Division of Foreign Plant Quarantines has undergone great changes to keep pace with present-day shipping conditions. Convoys, rules against use of radio announcing location and arrival time, and secrecy as to ports of arrival have combined greatly to increase the work of the port inspectors.

The experience gained in the cooperative programs for controlling outbreaks of grasshoppers, Mormon crickets, and chinch bugs led to the decision to organize this work in a separate division. The new division, called the Division of Grasshopper Control, is led by Claude Wakeland, who has been in charge of field work since 1939, with headquarters in Denver, Colo.

In May announcement was made of the appointment of J. F. Martin as Chief of the Division of Plant Disease Control to succeed S. B. Fracker, who was transferring to the Agricultural Research Administration. Dr. Martin has served as Assistant Chief of the Division since it was created in 1935.

Just at the end of the fiscal year Miss Mabel Colcord, who for almost 38 years had been in charge of the Bureau library, retired. Shortly before her retirement the library work of the Department was consolidated under the Department Librarian.

At the close of the year also the Bureau lost the services, by retirement, of Lon A. Hawkins. He had had 35 years' service in the Department, 23 years of which were spent as physiologist in the Bureau of Plant Industry. Then for 4 years he served as Chief of the Technological Division of the Bureau of Plant Quarantine, and for the last 8 years as Chief of the Division of Control Investigations of the Bureau of Entomology and Plant Quarantine. For the time being it has been decided not to fill formally the vacancy left by his retirement. Work of the Division of Control Investigations is being administered by Curtis P. Clausen, Chief of the Division of Foreign Parasite Introduction, who will function as chief of the two divisions. This does not imply consolidation of the two divisions at this time.

On July 10, 1942, Emory C. Cushing, Chief of the Division of Insects Affecting Man and Animals, left the employment of the Bureau to serve as major in the Sanitary Corps of the United States Army. He is succeeded by W. E. Dove, who has been in charge of research work on mosquitoes and other insect pests of man and livestock in the Southeast.

It has long been realized that there was need for additions to the administrative staff of the Bureau more nearly to keep pace with increasing volume and complexity of the work. It was decided to reorganize along lines which provide for the position of Associate Chief, sharing responsibility for all activities of the Bureau, and for four Assistant Chiefs of Bureau, designated for specific lines of work, regulatory, research, control, and administration. A. S. Hoyt and S. A. Rohwer, formerly Assistant Chiefs, were appointed Associate Chief and Assistant Chief for regulatory work, respectively. F. C. Bishopp, former Chief of the Division of Insects Affecting Man and Animals, was appointed Assistant Chief for research, W. L. Popham, who had been Assistant Chief of the Division of Plant Disease Control, was appointed Assistant Chief in charge of control, and F. H. Spencer, Bureau business manager, became Assistant Chief responsible for administration.

EDITORIAL WORK AND PUBLICATIONS

At the beginning of the year 238 manuscripts were on hand, and during the year 488 were received, making a total of 726. Of these, 13 were withdrawn, 61 were published by the Department, 53 were

issued in processed form by the Bureau, and 355 were approved for publication outside. On hand at the end of the year were 243 manuscripts, 174 of which were in the Bureau, 45 in the Office of Information, and 24 at the Government Printing Office. Of the 174 in the Bureau, 79 were being reviewed or edited for departmental publication and 95 for publication outside.

The Bureau's 61 Department publications included, in addition to the Annual Report of the Chief of the Bureau, 14 Circulars, 9 Farmers' Bulletins, 1 Leaflet, 6 Miscellaneous Publications, 7 Picture Sheets, 4 Service and Regulatory Announcements, 13 Technical Bulletins, and 6 articles for the Journal of Agricultural Research.

INSECT PEST SURVEY AND INFORMATION

The Insect Pest Survey added to the permanent files on distribution and abundance of foreign insects 13,000 notes and 2,635 species not heretofore recorded. The note files on domestic insects were augmented by the addition of 17,000 notes and 475 species heretofore unrecorded. The index on specific plants attacked by insects has been increased by 550 new genera and 1,800 species on which there are known insect pests.

The Survey was called upon to make detailed reports on Survey data on 115 subjects from the several divisions of the Bureau and outside agencies.

Volume 21 of the Insect Pest Survey Bulletin, with 8 supplements, comprising 873 pages, was finished, and 3 numbers of Volume 22 were published. Publication of this bulletin was discontinued with the May 1942 issue.

A total of 122 press releases and 89 radio releases on entomological subjects were approved. Sixteen exhibits at various meetings and expositions, in addition to the regular exhibit material for State fairs in the hands of the Agricultural Exhibits Section of the Extension Service, were shown before exhibit work was discontinued in May 1942.

The number of printed publications of the Bureau distributed from this Division totaled 363,000, not including mimeographed and other processed material.

The mailing lists maintained in this office now include approximately 35,000 addresses on 35 lists, two new mailing lists having been added during the year. Requisitions for handling duplicating and photographic material numbered 1,666 and covered orders for 937,976 copies.

Ten numbers of the Bureau's News Letter, comprising 305 pages, were issued. It was discontinued with the April number.

To the file of photographic prints 230 new subjects were added, and 1,197 prints were furnished upon request.

COOPERATIVE FIELD RELATIONS

Some of the Bureau programs of work are carried on in every State, and the cooperation with State agencies is wide and varied. The Division has devoted particular attention to certain of the pest-control programs, studying ways in which those activities affect cooperating State agencies and private individuals. Information obtained in these studies will be carefully reviewed to determine ways in which present procedures can be improved or modified.

FRUIT INSECT INVESTIGATIONS

APPLE AND PEAR INSECTS

In continued field tests in several localities micronized phenothiazine again gave control of the codling moth about equal to that obtained with lead arsenate. The regular phenothiazine, which has a greater particle size, gave much poorer results. In certain cases the phenothiazine, especially the micronized form, had some adverse effect on color, or retarded ripening and reduced the size of the fruit.

A new formula for a tank-mix nicotine bentonite combination was developed at the Vincennes, Ind., laboratory. This formula includes a cheap, low-swelling Mississippi clay in place of Wyoming bentonite and mineral oil in place of soybean oil. It gave good control of the codling moth under experimental conditions and left little visible residue on the fruit.

Xanthone used against the codling moth at the Yakima, Wash., laboratory left the fruit considerably wormier than did lead arsenate, although the total injury was about the same. Its use in the early cover sprays again caused some russetting of the fruit. In the Middle West and the East xanthone was definitely less effective than lead arsenate.

Among the several hundred insecticide materials given preliminary testing during the year were a few that warrant further study, including an alkaloid isolated from the Chinese thunder-god vine (*Tripterygium wilfordii* Hook., f.). At the Vincennes, Ind., laboratory it was discovered that certain soybean phosphatides could be used in small quantities with various oils to produce spray mixtures with good deposit-building properties unaffected by hardness of the water.

The study of the scale insect *Parlatoria chinensis* (Marl.) at St. Louis, Mo., showed that this insect had two complete generations and a partial third during 1941. Summer oils at strengths of 2 to 3 percent killed a high percentage of all stages, and dormant-type oils at 4 percent likewise gave a high kill.

From experiments conducted as a basis for the control program against the pear psylla, it was determined that mineral oil of approximately 200 seconds Saybolt viscosity could be used on pear trees in the Northwest at a concentration as high as 10 percent for dormant spraying, with no detrimental effect on the trees other than a temporary slowing up of the spring development. The usual strength is 3 or 4 percent.

New infestations of the Comstock mealybug have been found in Connecticut and New Jersey. Five species of parasites introduced from Japan have now been colonized in 24 orchards in Virginia, West Virginia, Ohio, Georgia, and Connecticut. One species, known as *Allotropa* sp. No. 1, survived the winter very well at several of the colonization points in Virginia, West Virginia, and Ohio, and multiplied and spread in several of the orchards.

PEACH INSECTS

The feasibility of breeding parasites in large numbers for mass liberation against the oriental fruit moth was demonstrated. In a breeding cage over 0.1 acre of strawberries infested with the straw-

berry leaf roller, an alternate host, adults of *Macrocentrus ancyli-vorvus* Roh. were produced at the rate of 630,000 per acre, a quantity sufficient for mass liberations in about 1,200 acres. In one preliminary experiment, in which bait traps were used to supplement the mass liberation of parasites, extremely low fruit injury followed in comparison with that in untrapped orchards.

Soil treatments with dichloroethyl ether emulsion in two applications to the ground under the spread of the peach trees, combined with jarring to catch overwintered adults, were shown in Georgia to be as effective against the plum curculio as the regular lead arsenate spray program.

Surveys in connection with the possible insect transmission of peach virus diseases were continued. In orchards where the phony peach disease occurs, 1,299 lots of insects were collected at 47 stations in 36 localities in 13 States. In orchards where the peach mosaic disease occurs, an estimated 4,725 accessions were made to the records from 34 sampling stations in 7 States. Transmission tests with the vector suspects of these virus diseases are being continued. The collection and testing of possible vectors of the western "X" disease of peaches is being continued incidental to the mosaic-insect survey.

GRAPE INSECTS

In large-scale experiments to develop substitutes for lead arsenate for the control of the grape berry moth in the Lake Erie grape belt, a combination spray schedule of arsenicals in the early spray, followed by processed nicotine bentonite, gave better results than an all-season program of nicotine bentonite. A micronized phenothiazine was superior to the standard phenothiazine and was highly effective in control. A hooded spray boom, which permits spraying in fairly windy weather, was used in the experiments in 1941 and proved satisfactory.

NUT INSECTS

Experiments in Georgia on the control of the rickory shuckworm on pecan by burying the fallen nuts with a disk tiller have continued to give favorable results. In experiments in Texas to control the pecan nut casebearer, a combination spray of lead arsenate, nicotine sulfate, and summer oil gave a yield of nuts two to three times as great as lead arsenate alone. An investigation of the pecan weevil has been started in central Texas, where a high percentage of the crop is being destroyed in some orchards.

Normally there is but one generation a year of the filbert worm (*Melissopus latiferreanus* (Wlsm.)) in Oregon, but a second generation has occasionally been noted. Some of the insects have been found to have a 2-year life cycle in filbert nuts, Catalina cherries, oak acorns, and hazelnuts, and even a 3-year cycle in Catalina cherries.

DRIED-FRUIT INSECTS

In tests to determine the effect of low temperature on dried-fruit insects, adults of the saw-toothed grain beetle and full-grown larvae of the Indian-meal moth succumbed when held at 32° F. for 22 and 23 days, but full-grown larvae of the raisin moth were not all killed after 125 days. Exposure to a temperature of 36° F. killed all the

first two insects in 33 and 47 days, but 26 percent of the raisin moth larvae survived an exposure of 130 days.

SUBTROPICAL FRUIT INSECTS

In the fumigation work against the California red scale on citrus, improvements were made in the blower-type applicator to adapt it to field conditions. As now designed, this applicator will give immediate distribution of hydrocyanic acid gas in the tent under varying field conditions, and consequently a more consistent control of the scale. Uniform peak concentrations are not always obtained, however, and further tests, including a study of tent fabrics, are being carried on.

Field experiments to control the citrus thrips on lemons in southern California indicate that tartar emetic spray is more effective than sulfur dust.

Work with several types of oil on citrus in Florida included two highly refined oils and two lower grade oils. At 1.25-percent strength in the spray mixture all four oils gave low kills. However, one of the lower grade oils was more effective in killing the purple scale and the Florida red scale on grapefruit trees than were any of the other oils tested, and no injury to the trees occurred. Under Florida conditions the cheaper, red oils appear to be more practical than the more expensive, white oils.

THE JAPANESE BEETLE

The milky disease has given striking evidence of its value in controlling Japanese beetle grubs. In parts of Washington, D. C., where intensive colonization of the disease organisms has been made during the past two seasons, the grub populations dropped from between 20 and 50 per square foot in August 1941 to 9 or less early in June 1942. The adult beetle infestation in the treated areas was much reduced in 1942.

Micronized phenothiazine, used as a spray against adult beetles at the rate of 2 pounds to 100 gallons, with bentonite, was equal in repellent effect to the standard lead arsenate spray.

Studies of the use of paradichlorobenzene for the treatment of balled or potted nursery plants have further demonstrated a definite postfumigation residual effect. This finding has made possible a reduction in the required treatment period for nursery stock to permit movement outside the infested area. Ethylene dichloride emulsion has also given favorable results in tests to free balled nursery stock from infestation.

THE PEAR PSYLLA IN THE NORTHWEST

The pear psylla survey was continued in central and eastern Washington and northern Idaho and extended into Montana, Oregon, southern Idaho, western Washington, and, in cooperation with Dominion authorities, into British Columbia. One infestation of six trees was found near Milton, Oreg., just south of the Washington State line, and dealt with by the State authorities. Six infestations were found in Washington in Kittitas County and three a few miles south of Wenatchee. Repeated intensive inspections in the Peshastin and Mis-

sion Creek Canyons failed to reveal any evidence of the infestations discovered in 1940.

The survey in 1941 included the inspection of 22,644 properties with a total of 213,139 pear trees and revealed 23 new infestations. Infestations were found on 1,216 properties having a total of 41,172 trees, of which 11,711 trees on 958 infested properties were removed by the State. The spray program cleaned up 37 additional properties to the point where no insects could be found at the end of the season; the remaining infestations involved 221 properties having 24,407 trees. During the season 804,585 trees were sprayed, 450,589 by the growers and 353,996 by the Government.

THE HALL SCALE IN CALIFORNIA

A survey and preliminary observations were made to determine a basis for control measures against the Hall scale (*Lepidosaphes halli* Green) in California. The survey indicates that the center of the infestation is an almond orchard near Chico. The infestation appears to be restricted, but because of the obscure nature of the insect repeated inspections over a period of time will be necessary to determine the actual limits of distribution. Among the host plants are almond, peach, apricot, plum, nectarine, and cherry.

SURVEY OF *PARLATORIA CHINENSIS*

To obtain more information on the status of the *Parlatoria chinensis* (Marl.) scale infestation in St. Louis, Mo., a second survey was undertaken in November 1941 and completed in March 1942. The survey revealed no further infestations at any distance outside the areas discovered in the 1940-41 survey. It appears desirable to continue the survey work until there is assurance that the limits of the distribution of the insect have been reached.

FRUITFLY INVESTIGATIONS

In Hawaii a barrier in which sprays or traps are used indicates about a 50-percent reduction of fruitflies in vegetable plantings. Work there has been realigned in keeping with the emergency. Chemical "boosters" and selected colors have more than doubled the efficiency of lures for the Mexican fruitfly. The new research laboratories provided by the Mexican Government have been occupied. Accumulation of data in Puerto Rico has permitted the termination of the work there.

MEXICAN FRUITFLY CONTROL

Although infested fruit was found throughout the area regulated under Quarantine 64, the number of infested properties was the smallest since 1938, only 259 infestations being located. Likewise, the number of flies trapped was smaller than usual, only 244 adult Mexican fruitflies being taken in the traps.

Since the fruitfly infestation was relatively light, it was necessary to divert only 3,619 tons of citrus fruits to sterilization rooms before packing. This is about 35 percent of the fruit sterilized in 1941 and approximately 8.5 percent of that treated in 1939. This year, as in

preceding years, sterilized fruit shipped well and was favorably received in the markets.

The 1941-42 harvesting season opened October 1 and closed May 31. During that period 29,081 equivalent carlots of citrus fruit were certified for shipment from the regulated area, and 16,606 carlots were processed at the canning plants. The total fruit production for the season was 45,687 equivalent carlots.

JAPANESE BEETLE QUARANTINE AND CONTROL

TRAP SCOUTING IN NONREGULATED TERRITORY

Trap scouting to determine the distribution and status of the Japanese beetle outside the area regulated by the Federal quarantine was carried on throughout the summer in 462 localities in 39 States. Trapping was started on April 14 and concluded on September 19. In this work 78,509 traps were operated, a reduction of 4,510 below the number operated in 1940. In addition to the work in States now included under the Federal quarantine, some trapping was carried out in all nonquarantined States except Arkansas, Montana, Nevada, North Dakota, Oklahoma, and South Dakota.

The States, with the number of communities in each, in which beetles were trapped were as follows: Georgia 4, Illinois 4, Indiana 10, Kentucky 1, Michigan 4, Missouri 2, New York 13, North Carolina 18, Ohio 15, Pennsylvania 3, South Carolina 4, Vermont 2, Virginia 11, and West Virginia 3. Of the 94 cities and towns outside the regulated area where beetles were collected, 27 were first records. At 12 of these first-record infestations only a single beetle was collected. At 4 others 5 or fewer beetles were collected. In the remaining first-record localities soil treatment has been completed, or the locality has been included within the regulated area.

Trapping gave negative results in 21 States, in which 4,162 traps had been set in 146 localities. These States, with the number of communities trapped in each, were as follows: Alabama 2, Arizona 8, California 14, Colorado 8, Florida 18, Idaho 5, Iowa 1, Kansas 1, Louisiana 6, Minnesota 3, Mississippi 4, Nebraska 1, New Hampshire 5, New Mexico 3, Oregon 4, Tennessee 3, Texas 43, Utah 2, Washington 11, Wisconsin 3, and Wyoming 1. Trapping also yielded negative results in 31 localities in States where beetles were caught.

Early-season trapping activities began the latter part of April with the sending south of a trailer truck loaded with Japanese beetle traps, which were distributed in various cities. In Florida 300 traps were set in Miami, 292 in West Palm Beach, 300 in Tampa, and 200 in Clearwater.

During May and June trap captures were recorded as follows: In Florida, 1 at Jacksonville; in Georgia, 2 at Atlanta, 5 at Augusta, 3 at East Point, and 2 at Toccoa; in North Carolina, 3 at Burlington, 17 at Charlotte, 3 at Durham, 48 at East Spencer, 22 at Elizabeth City, 7 at Fayetteville, 10 at Gastonia, 2 at Greensboro, 3 at Hamlet, 4 at High Point, 32 at Raleigh, 14 at Rocky Mount, 28 at Salisbury, 1 at Thomasville, 7 at Weldon, 17 at Wilmington, and 10 at Wilson; in Ohio, 86 at Gallipolis; in South Carolina, 1 at Charleston, 1 at Columbia, 35 at Florence, 7 at Greenville, and 1 at Sumter.

The trapping survey was retarded during the spring because of war restrictions on the purchase of materials. No new metal was purchased for traps, and the amount of bait was limited because of the high price and scarcity of geraniol and eugenol. Existing traps and equipment were conserved, and many improvisations made to offset the effect of critical shortages of materials.

SUPPRESSIVE MEASURES

Lead arsenate surface-soil treatments were applied to 894 acres in the fall of 1941 and 94 acres in the spring of 1942, a total of 988 acres as compared with 1,014 acres during the last fiscal year. Treatments were applied in 9 States in 38 localities, 33 in the fall and 5 in the spring. A carbon disulfide application was also made at the St. Louis, Mo., airport on a vegetable-garden area of 1.7 acres.

In North Carolina soil treatments were completed in Burlington, Charlotte, Durham, Greensboro, High Point, Raleigh, Rocky Mount, Wilmington, and Winston-Salem. The total acreage covered was 303. An additional 300 acres have been inoculated with the milky disease at Asheville, where the infestation is still localized on a large estate.

Infestations in Ohio at Ashtabula, Belpre, Bucyrus, Conneaut, East Conneaut, Gallipolis, South Zanesville, Van Wert, and Zanesville have been adequately treated with lead arsenate. A total of 206 acres were covered.

Treatments covering 11.7 acres were applied in Atlanta and Chamblee, Ga.

Satisfactory treatments have also been completed in both Chicago and Highland Park, Ill., covering 170 acres.

In Indiana it was possible to reduce greatly the acreage requiring treatment, since the only infestations of such scope as to demand treatment were at Elkhart, Fort Wayne, Hammond, Indianapolis, Logansport, Richmond, and Terre Haute. The area treated totaled 104 acres, as compared with 219 acres last year.

Michigan's cooperative soil-treating program in 1941 extended to 3.6 acres in Birmingham, 9.2 acres in Dearborn, 57 acres in Detroit, and 3 acres in Melvindale. This was a complete coverage of all infested sections within the State.

The infestation in St. Louis, Mo., was reduced from 30 beetles captured in 1940 to 15 during the current year, as a result of previous years' treating programs. Treatment of 5.5 acres was made to suppress this infestation. At Bridgeton, where the St. Louis-Lambert Airport is located, 11.4 acres were treated to cover the locations at which 3 beetles were trapped.

Cooperative treatments in New York State in the fall comprised the application of lead arsenate to 63.5 acres in Newark, and in the spring to 35 acres in Niagara Falls.

In Vermont, at Barre, where 21 beetles were trapped, lead arsenate was applied to 5.7 acres in the spring.

As in previous years, all treatments were conducted on a cooperative basis, this Bureau furnishing equipment, drivers and operators, and supervisors, while the cooperating agencies furnished labor and materials and made all local arrangements for permission to treat private properties and for the use of the water supply.

FEDERAL AND STATE REGULATORY MEASURES

A revision of the Japanese beetle quarantine and regulations, effective March 24, 1942, made relatively small extensions in the regulated areas in Maryland, New York, Pennsylvania, Virginia, and West Virginia. The new areas brought within the regulations are the following: In Maryland, portions of Allegany and Washington Counties and the previously unregulated portions of the counties of Carroll, Frederick, and Prince Georges; in New York, Manchester in Ontario County and Pittsford and East Rochester in Monroe County; in Pennsylvania, Meadville in Crawford County; in Virginia, Charlottesville in Albemarle County, Danville and Schoolfield in Pittsylvania County, Front Royal in Warren County, and Newport News (including Camp Stuart, heretofore under regulation) in Warwick County; in West Virginia, Lincoln in Tyler County and Paden City in Wetzel County.

The more heavily infested area from which the movement of fruits and vegetables is under regulation was extended under this revision to include additional districts in Anne Arundel and Baltimore Counties, Md., and in Berks, Cumberland, Lehigh, Northampton, and York Counties, Pa. In addition, a few minor changes were made in quarantine regulations relating to exempted articles, movement of cut flowers, maintenance of classified status at an infested nursery or greenhouse, and the issuance of permits for movement of restricted articles via motor truck.

HIGHWAY INSPECTION SERVICE

At the peak of the season 19 regular stations and 1 "floater" station were operated in Ohio, West Virginia, and Virginia. The maximum number of road inspectors employed for operation of the posts during the summer was 66. By the end of September the number of regular stations had been reduced to 9, and during October, 7 of these were closed, leaving only 2 stations, near Fredericksburg, Va., which were closed November 22 and January 15. Two Japanese beetle larvae were found in soil of 12 miscellaneous plants inspected at the station open in January.

Early in 1942 the system of motor-vehicle inspection was changed, because the use of passenger automobiles had been curtailed to such an extent that they were no longer an important factor in spreading the Japanese beetle. The new system involved the spot checking of all the important roads by a smaller number of mobile quarantine inspectors during most of the periods when restricted articles were moving by road. However, during the summer on the important roads leading south from the regulated area, road posts for truck inspection only were operated on a 24-hour basis.

Road patrol began the last of April and early in May in Virginia with 3 inspectors, and 3 men were assigned to check the roads in Ohio a few days later. During June, 4 regular and 2 floater stations were operated in Virginia by 15 men, and 1 post was operated in West Virginia by 2 men.

In the attempt to prevent rapid long-distance spread of Japanese beetle adults by means of airplanes, the inspection of planes leaving the principal airports in the heavily infested area was continued

during the summer of 1941. Two men were stationed (part time) at Newark, N. J., where 2 beetles were intercepted; 1 man at Philadelphia, Pa., where 52 beetles were intercepted; 2 men at Washington, D. C., where 368 beetles were found; and 3 men at LaGuardia Airport, Long Island, N. Y., where 238 beetles were found. Of this total of 660 beetles, 49 were found inside planes and 611 near the planes, on passengers or employees entering planes, or on mail sacks, express, or baggage.

During the year 1,353 empty trucks returning to southern points after driving through infested sections were found to contain 9,285 beetles. Forty lots of infested plant material were intercepted at the posts, from which 8 beetles, 170 larvae, and 1 pupa were removed. The number of motor vehicles stopped at the road posts for inspection totaled 2,892,553, of which 9,283 were transporting uncertified quarantined articles. A total of 213,167 packages of fruits, vegetables, and cut flowers were certified by road-patrol inspectors.

CERTIFICATION AND TREATMENT OF NURSERY STOCK

Nursery and greenhouse scouting for the Japanese beetle was begun early in July 1941 and was concluded by September 11. From 2 to 4 scoutings were made in approximately 1,400 class I nurseries and greenhouses and in the screened units of class III establishments. In addition, scouting was done on the premises of 1,000 sources of soil, manure, and similar materials. Infestations were found on approximately 60 class I establishments, thereby placing them in class III status. Japanese beetles were collected in 142 nurseries and greenhouses.

As a rubber- and gasoline-saving measure all class I establishments that had required a minimum of certification during the year were urged to relinquish their classified status so that it would not be necessary to scout their premises in 1942. Many growers have voluntarily dropped their classification for the duration of the war, and their requirements for certification will be met by visits from an inspector whenever material is ready for inspection and certification.

Supplements or revisions of administrative instructions prescribing conditions for the treatment and fumigation of nursery stock were issued on August 6, 1941, and April 23, and May 7 and 18, 1942. These modifications provided for greater latitude in the size and temperature of soil balls in the methyl bromide fumigation of balled nursery stock, for the fumigation of boxed and wrapped plants under established temperature and dosage schedules for the treatment of balled stock, for a further reduction to 1,000 pounds per acre in the quantity of lead arsenate to be used in field treatments of growing nursery stock, and for a reduction from 5 to 3 days in the paradichlorobenzene treatment of nursery stock.

At the end of the year the number of classified nurseries and greenhouses was 1,312, as compared with 1,832 at the end of the previous year.

CERTIFICATION OF FRUITS, VEGETABLES, AND CUT FLOWERS

During the period of adult-beetle flight in 1941 inspection centers were in operation at 22 points throughout the regulated area—9 in Delaware, 1 in the District of Columbia, 4 in Maryland, 3 in New Jer-

sey, 1 in Pennsylvania, and 4 in Virginia. Drought, which resulted in a drastic reduction in the acreage of beans and potatoes harvested in New Jersey and on the Eastern Shore of Maryland and Virginia, was responsible for a large reduction in the quantities of fruits and vegetables inspected and certified. During the period of the quarantine on fruits, vegetables, and cut flowers, inspectors at the field offices removed 3,111 beetles from 1,871,075 packages of commodities certified for transportation, as compared with 4,205 beetles removed from 2,887,574 packages during the previous year.

ARTICLES CERTIFIED AND VIOLATIONS INVESTIGATED

A total of 243,389 certificates of all kinds were used to cover quarantined products moving to nonregulated territory. Nursery and ornamental stock totaling 39,857,639 plants and 903,215 pounds of sand, soil, earth, peat, compost, and manure were certified for shipment from class III establishments in the regulated area. A total of 1,956,929 packages of fruits and vegetables and 127,313 packages of cut flowers were certified during the seasonal quarantine on these articles. In addition, 16,355,995 plants were shipped from class I establishments to points in nonregulated territory and to other classified establishments in the regulated area. Furthermore, 26,692,223 plants were certified for shipment between dealers in the entire Japanese beetle regulated area.

Investigations were made of 947 apparent violations of the Japanese beetle quarantine regulations. They included interceptions by transit inspectors of the Bureau stationed at postal and common-carrier terminals and by highway inspectors examining road vehicles. No prosecutions were undertaken.

PHONY PEACH AND PEACH MOSAIC DISEASE CONTROL AND ERADICATION

Control and eradication work was continued in cooperation with pest-control agencies of 18 Southern and Western States. During the year 423 nurseries, containing more than 12,000,000 peach trees, and their environs were inspected, and all disease trees eliminated, to prevent spread of the diseases by infected nursery stock. Three nurseries, containing less than 2 percent of the stock inspected, failed to meet the certification requirements. The States maintained their standard quarantines regulating the movement of nursery stock, and the Bureau assisted in their enforcement.

In the area affected 13,098,343 orchard trees were inspected, and 79,820 phony and 19,240 mosaic infected trees were found, of which 93,229 were removed. Kentucky and North Carolina were added to the list of States freed from the phony peach disease. Indiana, Maryland, Oklahoma, and Pennsylvania had previously been cleared of the disease.

In the Western States substantial reductions have been made in the incidence of trees newly infected with the mosaic disease. In California the number was reduced from 34,000 in 1937 to 4,337 in the calendar year 1941, in Colorado from 32,000, in 1935 to 7,280 in 1941, and in Utah from 1,082 in 1936 to 145 in 1941.

Through allotments of Emergency Relief Administration funds to the Department, labor was provided to remove nearly 3,000,000 escaped and abandoned trees to eliminate the hazard of their harboring the disease.

CITRUS CANKER ERADICATION

Intensive inspections were continued cooperatively with the States of Texas and Louisiana in areas found infected in former years, but no citrus canker was found anywhere. More than 11,000 properties were inspected. Inspections were conducted in nursery areas on the Gulf coast of Texas, in the Carrizo Springs-Crystal City and Laredo areas of Texas, and in 7 Louisiana parishes. Work Projects Administration laborers removed abandoned and escaped citrus trees, principally *Citrus trifoliata*.

INVESTIGATIONS OF INSECTS AFFECTING FOREST AND SHADE TREES

The work of this Division has been modified to give all aid possible to the war effort. These activities have centered around the protection of mature stands of pine timber from bark beetles and salvaging bark beetle-susceptible timber, aid to the Federal housing agencies and the War and Navy Departments in protecting buildings and other wooden structures from termite damage, and efforts to improve control methods against the gypsy moth and the Dutch elm disease.

COOPERATIVE BARK BEETLE SURVEYS

To guard against western pine beetle outbreaks in ponderosa pine forests, which have caused so much destruction in recent years, another region-wide bark beetle survey was conducted in cooperation with the Forest Service, the Office of Indian Affairs, and private timber owners. About 16,000,000 acres of commercial ponderosa pine in Oregon, Washington, and California were covered with observational surveys, and about 150,000 acres of sample plots were intensively cruised. It was found that pine beetle activity in 1941 had declined from the high level of previous years, and direct control action was not called for in any part of this region, except in recreational areas in southern and central California. Several million acres were covered in the white pine, ponderosa pine, and lodgepole pine sections of the northern and central Rocky Mountains.

SANITATION-SALVAGE LOGGING

Control of pine beetle infestations through selective logging of high-beetle-risk trees has continued to find favor with pine operators and on national forests in California and Oregon. This method fits in well with the increased lumber production stimulated by war demands. High-risk trees selected for cutting yield a large percentage of the lower grades of lumber used by war industries, and their removal protects the reserve stand from bark beetle epidemics. As a result a larger supply of high-grade lumber will be preserved to meet the postwar market than if only the regular methods of cutting were employed.

During the year the Forest Service put into effect sanitation-salvage sales amounting to approximately 30 million board feet of high-risk

trees in California. Private operators are also shaping cutting programs so that areas of high insect hazard will be harvested during this period of increased demand. There are many thousand acres of pine timberland in this area on which the hazard of bark beetle attacks is high, where such preventive treatment might well be applied to forestall pine beetle damage.

The marking of beetle-susceptible trees, which is the basis of this method of logging, depends on the recognition and definition of certain characteristics of these trees. Additional studies were conducted during the year to appraise the value and relative importance of various tree characters indicative of high risk to beetle attack. About 5,000 trees on twenty 10-acre sample plots were carefully described as to all visible symptoms which might be indicative of risk. Fatal beetle attack of certain of these trees will indicate which of the early symptoms are of value in predicting the tree's death.

TERMITES AND DEFENSE HOUSING

The increase in construction of new houses for civilian defense workers and quarters for the armed forces has created a demand for more service in the application of methods for guarding against termites. Prevention of waste is the keynote of the project. Although the Army and Navy are faced with the necessity of erecting many temporary buildings for which they are giving little or no consideration to termites, they are making an effort to guard against and combat termites in buildings at the older and more permanent camps. Alterations in conventional types of construction, particularly at entrance platforms, which are the most vulnerable parts of buildings from the standpoint of termite attack, have been developed in cooperation with several architects. Some of these alterations have been accepted and are being adopted by the regional offices of the Federal Public Housing Authority.

There is a tendency to use masonry instead of concrete for pier and complete foundations in basementless houses. Where complete foundations are specified, provision for ventilation is usually inadequate. To determine the termite hazard and possibly the means of overcoming it in such buildings, a study was made of similar construction located in a section of western North Carolina known to be moderately infested with termites. Results of the limited survey indicate that in areas of light to moderate termite abundance it is not necessary to require poured concrete piers or the capping of masonry piers with concrete, provided skirting is omitted and there is ample clearance and ventilation.

Laboratory tests have been conducted near Saucier, Miss., to determine the effectiveness of metal shields of various types in preventing upward tubing by the eastern subterranean termite (*Reticulitermes flavipes*. (Kol)). Such factors as width of horizontal projections, types of corners, smoothness of surface and thickness of material, and angles were considered. Results of these laboratory tests indicate that shields are not infallible and, if installed for the added protection they give, they must be inspected annually for any termite tubes which may cross them. The most effective shields are of durable metal, providing a smooth surface with thin edges. The outer edge of the shield must be at least 2 inches from any object that comes in contact

with the building. A simple flat or horizontal shield that projects 2 inches from the pier or wall affords practically as much protection as any other type and is simple to install. Shields must be continuous, with all joints smoothly soldered, and holes cut in the shields for anchor bolts must be sealed with coal-tar pitch. On recommendation of this Bureau, termite shields have been omitted from practically all Army, Navy, and Federal Public Housing Authority construction begun in the last several months, and large savings may thus be effected.

THE GYPSY MOTH

Although studies of the gypsy moth have been under way for many years, there is still urgent need for more information. It is particularly important to cheapen and make more effective the control methods used to prevent spread of this insect into new areas, and it is important also to devise better silvicultural methods of growing forest crops in the region now infested.

For a number of years insecticides other than lead arsenate for controlling the gypsy moth have been given some attention. It has been found that pyrethrum is very toxic to small caterpillars, while cryolite and some of the dinitro-o-cyclohexylphenol compounds show promise in killing caterpillars of all sizes. All these materials are relatively noninjurious to man and domestic animals. An expanded program of work for further investigation of these and other insecticides was initiated in the spring of 1942. The need for this work is emphasized by the shortage of lead arsenate resulting from war demands.

CONTROLLING VECTORS OF THE DUTCH ELM DISEASE

Control of the Dutch elm disease is resolving itself more and more into a problem of controlling the insect vectors. Experiments on the use of trees injected with chemicals for elm bark beetle traps were continued. The results show that trees treated with sodium chlorate (10 grams per d. b. h. inch) plus sodium arsenite ($\frac{1}{4}$ gram per d. b. h. inch) are effective in attracting bark beetles and killing them and their offspring. It has also been shown that sodium bisulfite can be used in place of sodium chlorate in equal dosages. Adults of *Scolytus multistriatus* (Marsh.), the principal insect carrier of the Dutch elm disease fungus, when attracted to these trap trees can be collected and cultured to determine whether the fungus is present. A possible use for such traps in locating outlying infections of this disease is indicated.

Continued experiments with sprays to repel or destroy elm bark beetles have shown that monochloronaphthalene plus fuel oil (1 to 10 parts by volume) is as effective as orthodichlorobenzene plus fuel oil (1 to 4 parts by volume). This is important in view of the scarcity of certain chemicals during wartime.

INSECT DAMAGE IN FOREST PLANTATIONS

In the Lake States efforts have been continued in cooperation with the Forest Service to devise methods of protecting from insect defoliators the extensive second-growth stands and plantations. At least four types of insects are capable of doing serious damage to pine plantations. The white-pine weevil is the most important be-

cause it gives rise to crooked trees, but spittle bugs, at least two species of sawflies, and the pine chafer are also injurious. As direct control of these pests is impractical in extensive forest plantations, the Division's studies are directed toward finding methods that can be incorporated in the management of the stand. At present it is working with the Forest Service in developing methods of thinning and stand improvement which may prevent future serious insect damage.

GYPSY AND BROWN-TAIL MOTH CONTROL

DEFOLIATION

Defoliation caused by the gypsy moth during the summer of 1941 was slightly less than in the previous year. Approximately 468,000 acres were from slightly to completely defoliated. In Massachusetts there was an increase in the area defoliated, but in Maine, New Hampshire, and Vermont it was slightly less than in 1940. No defoliation was reported from barrier-zone towns or the infested area of Pennsylvania.

Recent surveys of woodlands where heavy defoliation has occurred, principally in recent years, show many dead and dying trees, including oak, pine, and hemlock. This condition is present in such widely separated areas as the towns of Granby, Canton, and Simsbury in Connecticut; Dartmouth, Falmouth, Harwich, Brewster, Manchester, Essex, and several towns in Franklin and Hampshire Counties in Massachusetts; the Sebago Lake district in Maine; and the vicinity of Lake Winnepesaukee in New Hampshire.

HATCHING AND EGG-CLUSTER DEPOSITION

Egg deposition during the summer of 1941 was lighter in much of the infested area than it has been for several years. In the spring of 1942 hatching occurred the last of April, several days earlier than normal, and it was poor in many localities. Examination of a small number of egg clusters collected from 25 towns between the barrier zone and the Connecticut River in Massachusetts and Vermont showed a hatch of only 42 percent, as compared with 60 percent from egg clusters collected in 27 towns in the barrier zone. Freezing temperatures early in May killed tender foliage in many areas, especially that of white oak, and undoubtedly many small larvae were destroyed by cold or starvation.

ASSEMBLING-CAGE WORK

During July 1941, 2,594 charges of attractant were distributed in New York, New Jersey, and Pennsylvania. In New York State west of the Hudson River 495 cages were placed in 7 townships, and in northern New Jersey 205 cages were distributed in 22 townships. No males were caught in either State. In Pennsylvania 1,894 cages were placed in 15 townships, and 113 male moths were caught at 36 locations in 8 townships. The distribution of these catches indicated that no spread to the east had occurred, but 3 centers of infestation north-east of the lightly infested area were discovered and treated.

During the summer of 1941 female pupae were collected to obtain the assembling-cage material for use in July 1942. The New York

State Conservation Department assisted in this work. From 323,530 female pupae enough material was obtained to prepare 4,183 charges, 300 of which were distributed in Pennsylvania during the summer of 1941. Of the 3,883 charges that were kept through the winter, 500 were sent to Washington for research purposes.

GYPSY MOTH CONTROL WORK

The regular appropriation for 1942 was supplemented by \$773,814 in WPA funds, but owing to labor shortage less than 60 percent of this amount was expended. Federal-agency projects were terminated by law on December 31, 1941, but continued participation in the WPA program was made possible through federally sponsored projects operating under the State programs. Only 62 percent of the workers promised for this work were furnished by the WPA, and this fact, coupled with the heavy turn-over in personnel and the poor physical condition of the workers, made it impossible to cover nearly all the territory planned. In Connecticut all WPA work was suspended on March 31, 1942, and was not resumed.

BARRIER ZONE AND ADJACENT TERRITORY

Scouting and treatment work was limited to dangerous areas not covered during the 2 preceding years and to an intensive check-up of the most serious infestations found and treated in 1941. Work in New England was confined to the barrier zone and a few areas on high elevations in Massachusetts bordering the zone.

In Connecticut, where relief labor was extremely scarce, arrangements were made whereby a small force of State employees scouted and applied treatment where necessary within the zone in dangerous territory that would not otherwise have been covered. A few regular employees were also detailed to special survey work in wooded areas to determine whether any infestations were building up on high elevations from which wind spread might occur. In New York, with the exception of Clinton County, bordering Canada, WPA, CCC, or regular State forces scouted and applied treatment in threatening areas in all counties within the zone, as well as west of the zone in Saratoga, Greene, Ulster, Rockland, Westchester, and Nassau Counties. In the entire zone scattered infestations were found, but none were discovered north of Bristol, Vt., and Hague, N. Y., or south of Southbury, Conn., and Hillsdale, N. Y. No infestation was found on Long Island. A few isolated infestations were discovered in Saratoga and Ulster Counties bordering the zone on the west. All infestations found were treated.

In Connecticut the autogiro was used in treating 1,280 acres of lightly infested woodland located on high elevation in the town of Canaan, which, if neglected, might have been a source of persistent wind spread of small larvae. This is the largest area treated in a single year with this equipment, which applies lead arsenate combined with atomized fish oil in a specially devised distributor. Favorable weather and perfect operation of the equipment helped to make possible this accomplishment, which demonstrated the feasibility of its use in treating relatively inaccessible woodlands.

The workers provided by the WPA were sufficient to operate only 3 sprayers in Vermont and 5 in Massachusetts, which was about half the number planned for use in these States. Eleven sprayers remained idle throughout the year because there were no men to operate them. Although no Federal work was done in New Jersey, a small State force scouted selected areas in the 10 northern counties where the danger seemed greatest. Examination of 1,509 acres of nursery stock, 3,978 acres of woodland, 1,075 fruit trees, and 9,562 shade trees gave no evidence of the gypsy moth.

GYPSY MOTH WORK IN PENNSYLVANIA

In Pennsylvania scouting and treatment work was done within the territory under quarantine adjacent to the areas covered the previous year and in townships bordering the quarantined area in Wayne County, where male moths were attracted to assembling cages during the summer of 1941. Check-up work was also done at the sites of the most serious infestations found last year. Spraying of the infested residential areas was begun on May 15, but a few days later this work was interrupted by heavy rains. Broken water lines and damage to reservoirs made it impossible to continue residential spraying, and the equipment was immediately transferred to woodland areas, where spraying was begun on May 29. At first 29 sprays were used on the single-shift basis, but later 10 machines were shut down because the WPA did not furnish men to operate them. Spraying was discontinued July 2.

The State of Pennsylvania quarantine on account of the gypsy moth has been strictly enforced. Thirty-six of the 32,691 shipments were found infested by this insect. There were 57 violators of the quarantine regulations, 55 of whom were first offenders, who were issued warnings against repetition. The other 2 offenders, with previous violations, were successfully prosecuted by State authorities.

No evidence of the gypsy moth was found as a result of the burlapping and assembling-cage work carried on at Corry, in northwestern Pennsylvania.

A report of the discovery of the gypsy moth near McConnellsville, Ohio, in August 1941 was immediately investigated and found to be a mistake. The insect proved to be the green June beetle.

Table 1 gives a summary of scouting and control work done by the Bureau and cooperating agencies in 1942.

THE BROWN-TAIL MOTH

In the spring of 1942 there was a considerable reduction in the amount of defoliation caused by this insect, but it was extremely heavy in some towns in northeastern Massachusetts and in some sections of southwestern Maine, especially in an area along the coast north of Portland. In addition to heavy defoliation of neglected apple trees, numerous woodland oak stands were completely defoliated, as were many large oaks in residential sections.

TABLE 1.—Gypsy moth control work, fiscal year 1942

State	Project	Scouting						Thinning			
		Open country						Wood-land	Egg clus- ters creosoted	Wood-land	Trees cut in open
		Open areas	Roads	Apple trees	Oak trees	Shade trees	Wood-land				
Vermont	WPA and regular	Acres 48,284	Miles 235	Number 94,186	Number 8,607	Number 155,143	Acres 38,924	Number 139	Acres 24	Number 150	
Massachusetts	do	26,174	165	42,189	4,928	72,906	31,362	9,216	432	2,804	
Connecticut	WPA and regular ²	5,095	47	8,253	3,142	8,809	17,959	713	1	0	
New York	WPA, CCC, and State	152,458	1,060	259,001	5,990	1,014,761	116,496	2,388	987	0	
Pennsylvania	WPA and regular ³	53,604	455	179,835	43,303	616,549	91,709	194,256	121	1,485	
Total		285,615	1,962	583,464	65,970	1,868,168	296,450	206,712	1,565	4,439	

State	Project	Fencing		Banding		Spraying			
		Erected	Removed	Burlap bands ¹ applied	Pupae crushed	Larvae crushed	Wood-land	Residen- tial prop- erties	Trees in open
Vermont	WPA and regular	Feet 27,800	Feet 34,100	Number 7,674	Number 12	Number 10	Acres 232	Number 0	Number 0
Massachusetts	do	101,508	9,082	12,292	323,770	11,134	492	0	0
Connecticut	WPA and regular ²	7,200	118,156	11,396	592	7,208	1,260	0	0
New York	WPA, CCC, and State	0	0	3,584	0	272	1,205	0	0
Pennsylvania	WPA and regular ³	126,946	41,452	127,504	10,373	38,616	3,538	638	35,618
Total		263,454	202,790	162,450	334,747	57,240	6,727	638	35,618

¹ The majority of bands applied were of sticky material instead of burlap.

² Includes work performed by State of Connecticut crews in barrier zone.

³ Includes work performed by National Youth Administration workers.

GYPSY AND BROWN-TAIL MOTH QUARANTINE ENFORCEMENT

CERTIFICATION OF QUARANTINED PRODUCTS

Gypsy moth infestations removed from inspected products were fewer than in immediately preceding years owing to reduced infestation in many sections of the regulated area. Inspectors removed 3,615 egg clusters, 79 larvae, and 40 pupae from a total of 119,102 shipments. Shipments certified represented a 6.5-percent increase over last year's total, although the total quantities of products certified were less.

Shipments of lumber from New England again showed an enormous increase over any past record. Nearly 223 million board feet were inspected and certified for shipment outside the regulated zone, as compared with 138 million board feet during the previous report period. This increase was caused by the continued demand for lumber for new construction in connection with the accelerated war effort.

From 43,415 shipments of forest products certified, 3,330 egg clusters, 59 larvae, and 40 pupae were removed. Thirty-one egg masses were removed from 31,396 consignments of nursery stock certified. From 18,347 lots of evergreen products examined, 47 egg clusters were removed. In 25,944 lots of stone and quarry products examined, 207 egg clusters and 20 larvae were found.

Labor shortage was acute in some districts. Not only was it difficult for nurserymen to get help, but in some places it was impossible for the Bureau to hire temporary inspectors during the spring shipping season. Regular inspectors from Boston, Mass., and Bloomfield, N. J., were temporarily detailed to some of the larger New England nurseries.

Cutting of Christmas trees and other evergreen products was begun about the middle of October in many sections. Scarcity of labor compelled a longer season with fewer workers. During November and December, 31 temporary inspectors were employed, 28 of them for inspection of Christmas trees and evergreen boughs. There was a 26-percent increase in the number of Christmas trees inspected this year over last. The only infestation found in Christmas trees was one egg cluster on a tree shipped from Ludlow, Vt., to Youngstown, Ohio, in December.

Investigations were made of 508 apparent violations of the quarantine. The only modification of the quarantine regulations effective during the year was a revision authorized on July 8, 1941, to permit the interstate movement, under certain specified conditions, of forest products such as sawdust or shavings destined to processing or manufacturing plants in nonregulated areas. A revision of administrative instructions dated October 10, 1941, added a number of products to the list of articles exempt from gypsy moth certification requirements.

Among the products shipped in large quantities that were inspected and certified during the year were the following:

Logs, piles, post, poles, ship knees, and ties	pieces	380,079
Lumber	board feet	222,927,046
Shavings	bales	215,284
Miscellaneous forest products	pieces	242,130

Shrubs	number	2, 972, 111
Young trees	do	208, 014
Specimen evergreens	do	371, 575
Young evergreens	do	2, 637, 519
Seedlings, cuttings, and small plants	do	1, 387, 189
Boughs, balsam twigs, and mixed greens	boxes or bales	55, 249
Christmas trees	number	555, 056
Granite	pieces	59, 800
Paving blocks	number	173, 702

DUTCH ELM DISEASE ERADICATION

In the major disease areas of Connecticut, New Jersey, New York, and Pennsylvania, lack of manpower, reduced funds, and the termination or curtailment of the work previously performed by WPA labor necessitated a complete revision of the eradication program. Scouting was limited to a few State-designated control areas, for the most part concentrated in a border zone surrounding the major disease area and at points of isolated infection. In those sections of the control areas where systematic scouting comparable to that of the previous year was performed, no significant increase or decrease in confirmations was noted.

SCOUTING FOR DISEASED OR BEETLE-INFESTED ELMS

At the beginning of the year scouting operations were at a minimum pending an allotment of funds from WPA. By the end of July WPA projects had been resumed in all work areas except in Ohio, but many of the workers did not return, since they had obtained private employment or had been called for military service. The average number of scouts employed throughout the summer was approximately 550, fewer than the quota required for effective work. Since systematic scouting in the entire major disease area was therefore impossible, it was necessary to concentrate the surveys in certain control areas selected by State officials on the basis of valuable elm population in cities, towns, parks, and estates and on highways. The representative areas that were systematically scouted in 1940 were again thoroughly scouted in the summer of 1941, as a check on the development of the disease. The limited work in these representative areas furnished the only indication of disease incidence throughout the major disease area. Supplementing the control-area scouting, auto-giro scouting was conducted in Connecticut, New Jersey, and New York from July to September for the purpose of locating diseased trees in areas not covered by ground scouting, and especially in sections where the disease is intensified or is likely to become so.

Advance survey scouting in territory beyond the regular work area was carried on as usual, 11,701 square miles being covered on the first suspect survey and 11,279 on the second. In addition 18,405 and 8,691 linear miles of roadway were scouted on the first and second go-overs, respectively. As a result of this advance survey scouting a first-record infection was discovered at Alford, Berkshire County, Mass., and a diseased tree was found in Baltimore, Md., where the disease had not recurred since one confirmation was eradicated there in 1936.

Auto scouting for elms infested with the insect vectors of the disease fungus was started the first of October in Connecticut and New Jersey. Systematic beetle-material scouting got under way in New York, Pennsylvania, and the isolated areas at about the same time. During the year 65,201 elms were tagged as infested or subject to infestation by bark beetles. Of these, 48,480 were in isolated areas, 658 in Connecticut, 4,333 in New Jersey, 3,709 in New York, and 8,021 in Pennsylvania.

At the end of December WPA work was again suspended, but it was resumed early in the year, when separate projects were set up in the States. The WPA project in New York was abandoned, although a limited amount of eradication work is being continued under State sponsorship, and by the end of the year projects had been closed in Connecticut, Indiana, West Virginia, and several counties in New Jersey and Pennsylvania.

During the year 21,056 samples of elm wood suspected of containing the Dutch elm disease fungus were submitted to the laboratory for culturing. The fungus was isolated from 2,067 of these samples. Connecticut had 55 confirmations, New Jersey 1,084, New York 610, and Pennsylvania 138. In addition there were 180 confirmations in the isolated areas, as follows: Indianapolis, Ind., 6; Cumberland, Md., 3; Baltimore, Md., 1; Alford, Mass., 1; Binghamton, N. Y., 85; Athens, Ohio, 9; Wilkes-Barre, Pa., 74; and Cabin Run, W. Va., 1.

A total of 64,270 elms have been confirmed as infected since the disease was discovered in the United States in 1930. Segregated as to location, 1,780 were in Connecticut, 49,151 in New Jersey, 12,030 in New York, 657 in Pennsylvania, and 652 in the isolated infected areas. These isolated cases include 7 in Old Lyme and 1 in Preston, Conn.; 128 in Indianapolis, Ind.; 3 in Baltimore, 3 in Brunswick, and 5 in Cumberland, Md.; 1 in Alford, Mass.; 226 in Binghamton, N. Y.; 39 in Athens, 1 in Cincinnati, and 33 in Cleveland, Ohio; 193 in the Wilkes-Barre-Susquehanna area, Pa.; 5 in Norfolk-Portsmouth, Va.; and 6 in Wiley Ford and 1 in Cabin Run, W. Va.

EXTENSIONS OF WORK AREA

Extensions of the quarantined zone on October 1, 1941, to include all newly infected points in the major work area added 980 square miles to the regulated area. At the end of the year the work area comprised 1,540 square miles in Connecticut, 3,864 in New Jersey, 5,002 in New York, and 1,211 in Pennsylvania. Additions to the infected zone as the result of first-record infections discovered in or beyond the border-zone scouting area included 62 political subdivisions in 8 States.

ERADICATION AND SANITATION ACTIVITIES

In the same manner that scouting for diseased trees was affected by war conditions, the removal of diseased trees was drastically curtailed. In the major disease area tree removal was confined to the control areas. Eradication activities were intensified in a border zone about 15 miles wide around the major area. Similar intensive work was performed in and around the isolated infections.

Accomplishments of eradication crews included the removal of 2,238 elms confirmed as infected with the disease fungus, 85,345 trees in the

general elm-sanitation program, as well as 9,599 elms in selective operations, a total of 97,182. In addition 13,911 elms were pruned in conjunction with a pruning program to save valuable elms authorized late in November.

Since the inception of the eradication program in 1930 more than 4,500,000 elms have been removed by sanitation crews, beetle-infested material has been pruned from 311,000 elms, and over 1,270,000 elms have been removed in selective operations designed to facilitate scouting and at the same time benefit the remaining trees.

WHITE PINE BLISTER RUST CONTROL

ACCOMPLISHMENTS IN RIBES ERADICATION

Since 1933 most of the ribes-eradication work has been carried on with emergency relief labor. In recent years, however, the amount of this labor has gradually decreased, and during 1941 only about half as many individuals were employed as in the previous year. The chief source of this labor was closed at the end of December 1941, when all Federal-agency WPA projects were discontinued, and the termination of the Civilian Conservation Corps eliminated another group of workers. A few WPA laborers were assigned to control work on Bureau-sponsored State WPA projects, but several States have discontinued or curtailed these projects. This decrease in emergency relief labor has reduced the amount of ribes eradication, and more attention has been given to reeradication to maintain rust control on those areas already under protection.

Ribes-eradication work was continued by the Bureau in cooperation with the Forest Service of the Department of Agriculture; with the National Park Service, the General Land Office, and the Office of Indian Affairs, of the Department of the Interior; and with the affected States, counties, townships, timber protective associations, lumber companies, and individuals. A summary of the work accomplished by these cooperating agencies is shown in table 2.

TABLE 2.—Ribes-eradication work of all cooperating Federal, State, and local agencies during the calendar year 1941

Region	Initial eradication	Reeradication	Total initial eradication and re-eradication	Effective labor	Ribes bushes destroyed
	<i>Acres</i>	<i>Acres</i>	<i>Acres</i>	<i>Man-days</i>	<i>Number</i>
Northeastern States.....	208, 247	367, 325	575, 572	78, 609	5, 732, 116
Southern Appalachian States.....	479, 017	136, 855	615, 872	24, 923	2, 090, 146
North Central States.....	132, 442	157, 314	289, 756	54, 686	10, 899, 469
Western white pine States (Idaho, Montana, and Washington).....	20, 225	50, 992	71, 217	78, 265	8, 769, 780
Sugar pine States (California and Oregon).....	28, 384	35, 592	63, 976	39, 604	7, 058, 076
Total.....	868, 315	748, 078	1, 616, 393	276, 087	34, 549, 587

The labor involved represents the work of 6,943 men, including CCC enrollees, WPA labor, and temporary employees. The CCC enrollees were assigned from 89 camps in the white pine regions. In addition 67 camps were operated in remote forest areas, of which 14 were manned with relief labor and 53 with temporary employees of the Department and cooperating agencies.

White pine control areas in the United States aggregate over 28,000,000 acres. Through ribes eradication more than two-thirds of this acreage has been initially protected and about one-fourth has been reworked one or more times to maintain control of the disease. Once these areas have reached a maintenance basis, a small amount of work is needed each year to keep the control status and to eradicate ribes from new sites that are being taken over by natural reproduction or forest plantings.

SUPPLEMENTAL CONTROL ACTIVITIES

During 1941 the environs of 59 white pine nurseries containing over 79,000,000 trees were freed of ribes that averaged 3.8 bushes an acre. This was largely rework to prevent reestablishment. The continued eradication in white pine regions of the highly susceptible cultivated black currant resulted in the removal of 2,364 of these plants from 421 locations. Blister rust cankers were removed from 1,350,594 ornamental and planted pines to prevent them from being killed by this disease, and 44,067 fatally diseased trees were destroyed. The location and mapping of white pine stands of sufficient value to qualify for protection was continued, and control areas totaling 1,464,666 acres were mapped for ribes eradication.

DEVELOPMENT AND IMPROVEMENT OF CONTROL METHODS

Developmental work in methods for improving the efficiency of ribes eradication and studies in ribes ecology were continued in the western white pine and sugar pine regions. The special D-2 tractor, equipped with a front-end brush rake and a rear-end ribes hook, was used effectively in heavy patches of ribes on the Sierra and Plumas National Forests in California, with an estimated saving of about 65 percent of the man-days needed to do the work by hand. The operation of the hooks from the rear end of the tractor was facilitated by installing a pair of 12-inch steel rollers in a vertical position on the drum.

Repetition of controlled cross- and self-pollination tests on *Ribes roezli* Regel. confirmed previous data showing that wild ribes normally set fruit under natural conditions by cross-pollination. This finding should materially aid in the planning of long-range control work.

Further progress has been made in field studies designed to show the effect of grazing on the establishment of sugar pine, western white pine, and ribes; the differences in light, moisture, and temperature requirements for western white pine and for *Ribes viscosissimum* Pursh. and *R. lacustre* (Pers.) Poir.; and the effects of logging and burning on ribes regeneration with special reference to present methods employed in the silvicultural management of white pine areas.

SPREAD OF BLISTER RUST

The spread of white pine blister rust during 1941 was featured by a southward extension of the disease on ribes from central Virginia and West Virginia into northern Tennessee and North Carolina, and by the finding for the first time of large numbers of cankers on

sugar pine in northern California and southern Oregon in localities where ribes had been previously found infected.

In the Appalachian region the rust spread southward on wild ribes for about 134 miles. This spread is not especially serious from a control standpoint, since most of the valuable white pine stands within the newly infected counties already have been protected by the initial eradication of ribes.

In southern Oregon and northern California many more blister rust cankers were discovered on sugar pines than in past years. In Oregon the rust is now generally present in all counties where five-needle pines occur. Infections on pines and ribes were located for the first time in Annie Creek Canyon, Crater Lake National Park. In northern California infections were found for the first time on ribes in Mendocino and Humboldt Counties in the Coast Range, and in Sierra County in the Sierra Nevadas. The rust has thus spread southward in the Coast Range for about 200 miles and in the Sierra Nevadas for 170 miles. There was heavy intensification and local spread of the disease within some northern counties where ribes infection had previously been light. All pine infection found in California this year can be attributed to local origin. Ribes infections were limited to the general vicinity of "fruiting" cankers, except those in Mendocino and Humboldt Counties, which may represent long-distance spread since white pines are not very plentiful locally.

Scouting in 1941 extended the known limit of rust spread 6 miles farther south in the Sierras and that of pine infection about 60 miles. In Plumas and Sierra Counties infection on ribes was found close to the boundary of Yuba County. The most significant find was the discovery of infected sugar pine near Cascade in the southern end of the Plumas National Forest in Plumas County. Although one infected *Ribes roezli* bush was located in this area in 1938, no cankers were found on the pines. In 1941, 28 infected pines containing 74 cankers were located in 4 townships, and rust was found on ribes in 2 additional townships. The discovery of blister rust on sugar pine so far south in the Sierra Nevadas and the large increase in the number of infected pines indicate that the disease is becoming established over a wide area in northern California. In this part of the State 929 cankers were found on 331 pines. Prior to this only 4 pines with 4 cankers had been discovered in the Sierra Nevada and Cascade ranges in California. All pine cankers and all infected ribes that were located in these ranges during 1941 were destroyed.

The past year also appears to have been unusually favorable for rust intensification in northeastern Washington, northern Idaho, and northwestern Montana, because of abnormally wet conditions throughout the growing season. Infection was located for the first time in Glacier National Park on four pine trees near the north end of Lake McDonald. This represents an eastward extension of the known location of pine infection, although diseased ribes bushes were reported previously from Lake McDonald and elsewhere in Glacier National Park. The results of scouting in Yellowstone and Grand Teton National Parks were negative.

Some new centers of infection were found in the North Central and Northeastern States, but most of them were in locations already known to be diseased. The rust is distributed more or less generally in these

regions and continues to intensify on pines in unprotected areas. This condition is in sharp contrast to that existing on areas from which ribes has been eradicated, where it is difficult to find new cankers.

CEREAL AND FORAGE INSECT INVESTIGATIONS

INSECTS ATTACKING CORN

The European corn borer in 1941 continued its destructive attacks and was estimated to have caused losses aggregating \$4,935,990 in 258 counties surveyed in 18 Northeastern and East North Central States, where the total value of the crop was estimated at \$270,211,154. Considerable dispersion was recorded, principally in the upper Mississippi Basin westward and southward of territory previously known to be infested. In Illinois 26 additional counties were found infested, including Carroll County, bordering on the Mississippi River. In Indiana 15 western counties were added to the infested area, which now covers two-thirds of the State. In Wisconsin infestation was found in 7 additional counties, and half the State is now infested. With the discovery of newly infested areas in the Eastern States, the region affected is now known to extend southward from New England and New York through Pennsylvania, New Jersey, Maryland, and eastern Virginia to the south shore of Albemarle Sound in North Carolina. However, the protracted drought in the summer and fall of 1941 greatly reduced the abundance of this pest in much of that region. Reduction was also marked in the Lake States, except in western and southwestern Indiana and northwestern Illinois, where there was a distinct increase.

The breeding of corns resistant to corn borer attack is being strengthened, and the main focus of these studies has been moved from Toledo, Ohio, to Lafayette, Ind., to effect closer cooperation between Federal and State entomologists and agronomists.

The distribution of parasitic insect enemies of the corn borer has progressed well during the year, more than 66,000 parasites having been liberated in heavily infested territory. One species, a tachinid fly, *Lydella stabulans* var. *grisescens* R. D., has dispersed and increased rapidly since its release in New Jersey, until it is now present throughout a 300-square-mile area.

An important development in the studies of insecticidal control of the corn borer has been the improvement of spraying and dusting machines suitable for commercial use.

For control of the corn earworm the oil-pyrethrum method recently originated and announced by this Bureau is being adopted profitably and on a large scale by commercial growers of market sweet corn. This method is proving especially profitable in the Coachella Valley in California, where table corn is produced for the early market. Here in the spring of 1942 ear corn treated with oil-pyrethrum brought a premium of 75 cents per box over untreated corn. The average yield was 10,000 ears per acre, and the net profit, above the cost of treatment, was \$140 per acre.

GRASSHOPPERS AND MORMON CRICKETS

Grasshopper infestations became more restricted in area in 1941, owing to cool, rainy weather in spring and early summer, especially

in the eastern Great Plains. In the western half of this region, where the weather was favorable to grasshopper development, moderate to heavy populations matured and laid eggs that hatched in 1942. Surveys of the Crazy Mountain section in Montana and the Torrington area in Wyoming revealed that the grasshopper populations there were the lowest recorded in 10 years.

A partial second generation of the lesser migratory grasshopper occurred in western Kansas and neighboring areas in 1941.

In the studies of range-land grasshoppers it was found that the various injurious species exhibited marked preference as to locations for depositing their eggs. The data obtained are valuable in facilitating survey operations and will save time and expense in future control activities. A decline in the supply of arsenic for use in grasshopper bait stimulated the investigation of sodium fluosilicate as a substitute. This was found preferable to sodium arsenite because of its ready availability under war conditions, and because, since it is distasteful to livestock, there is little danger of poisoning from careless handling on farms. These investigations further showed that a waste industrial byproduct that contains 60 percent of sodium fluosilicate and 30 percent of calcium fluoride was a satisfactory substitute for the commercial grade of sodium fluosilicate.

Improvement in poisoned bait for the Mormon cricket was indicated in large-scale tests at Warm Springs, Oreg., and subsequent tests in northern Nevada. A bait in which the water was replaced by a much smaller volume of lubricating oil gave almost as good kills as that mixed with water. Three advantages of this oil bait are its good keeping quality in storage, elimination of the necessity of hauling large quantities of water for long distances in dry areas, and its suitability for application by airplanes. It was found that the concentration of sodium fluosilicate could be reduced from 4 pounds to 3 pounds per 100 pounds of bran without loss of final killing power. However, the higher concentration gave quicker kills. As a result of these studies the cost of Mormon cricket control has been reduced from \$1.54 per acre in 1938 to 59 cents per acre in 1941.

INSECTS AFFECTING FORAGE CROPS AND PASTURES

The vetch bruchid, a serious enemy of vetch seed, has continued to disperse and become more numerous in western Oregon and southwestern Washington. Good control of the insect in the field was obtained experimentally by applications of a rotenone-sulfur dust.

Studies of the legume weevil in the Yuma area of Arizona confirmed previous results showing that it cannot reproduce numerously on alfalfa but strongly prefers such relatively unimportant host plants in that area as sour clover and hubam clover. Plat experiments in cultural control indicated that timely cutting of alfalfa reduced legume weevil populations almost to extinction. In view of these findings and the necessity of eliminating all research not of immediate importance in the war program, studies of this insect were suspended as of April 20, 1942.

Observations on the pea aphid as an enemy of leguminous seed crops, extending over 20 years including 1941, have shown that serious injury was averted by delaying fall sowing until certain moderately late dates.

In studies on cultural control of white grubs through substitution of legumes, it was observed that heavier mortality of grubs in sweetclover than in bluegrass apparently was due to a less profuse root system of the sweetclover as well as to its greater extraction of water from the soil rather than to its unsuitability as grub food.

INSECTS ATTACKING SMALL GRAINS

A harvesttime survey of hessian fly conditions in winter wheat showed heavy infestations in western Kentucky, southwestern Missouri, southeastern Nebraska, and the eastern half of Kansas, and moderate to heavy infestations in Illinois, Indiana, and eastern Pennsylvania. This condition became intensified in the spring and summer of 1942.

The breeding of wheats resistant to the hessian fly was studied to determine whether races of flies capable of attacking resistant varieties of wheat might occur or develop if they had access to these wheats only. The results of these studies have been negative.

Among 3,000 American and foreign varieties of wheat tested, at least 50 have shown high resistance to fly attack. Several of these resistant varieties have been crossed with others having more desirable agronomic characters to produce advanced hybrids possessing high resistance to the fly as well as to one or more fungus diseases. Plantings of promising fly-resistant lines in a series of widely scattered uniform nurseries showed that several of them exhibited high fly resistance in all regions where tested.

THE WHITE-FRINGED BEETLE

An important desideratum for white-fringed beetle eradication or control is a satisfactory and economical soil insecticide. The larvae exhibited much greater resistance to arsenicals than the grubs of either the Japanese beetle or the common May beetles. For instance, 2,000 pounds of calcium arsenate per acre failed to kill all the white-fringed beetle larvae, whereas 1,000 pounds per acre was effective against the scarabaeid larvae. Moreover, the heavier applications caused serious injury to vegetation.

In the cultural-control experiments cowpeas and soybeans were more seriously damaged by equal populations of white-fringed beetle larvae than peanuts or cotton. A rotation to such fine-rooted crops as Bermuda or carpet grass was very unfavorable for the development of these larvae. During the period 1938-40 tests of a 1-year fallow on infested fields indicated an average reduction of 98.8 percent in larval populations.

Laboratory tests with *Neoaplectana glaseri*, a nematode parasite of the Japanese beetle, produced 32 to 100 percent mortality within 29 days. An undescribed species of the same genus endemic at Gulfport, Miss., produced 77 to 100 percent mortality within the same period. Field-plot tests with these parasites are proceeding at various locations in the infested area.

INSECTS ATTACKING STORED GRAINS AND CEREALS

Transportation of heavily infested grain in boxcars in the Central States during the moist summer of 1941 left a residue of insect infes-

tation in most of such cars. Steel boxcars thus infested and loaded with flour were effectively fumigated with methyl bromide at 2 pounds per 1,000 cubic feet of space for a period of 24 hours. This method was unsuccessful with wooden boxcars.

Tests of four types of sacks containing flour placed for a period of 4 months in infested warehouses in the Southern and Central States showed that well-made paper sacks with carefully sealed top and bottom gave excellent protection from most insect pests. However, the susceptibility to breakage through handling constituted a serious defect.

Research on insect infestation and control by fumigation in 250,000 bushels of wheat stored in about 130 steel bins at Hutchinson, Kans., and Jamestown, N. Dak., gave interesting results. At Hutchinson 43 percent of the bins were found infested with insects in October, while at Jamestown 19 percent had developed infestation by November 1941. A mixture of chloropicrin, $1\frac{1}{2}$ pounds, and carbon tetrachloride, 1 gallon, applied to 1,000 bushels of grain gave perfect results in tests but was objectionable because of its lachrymatory effect. Methyl bromide applied alone was found ineffective for fumigation of corn in steel bins, but by adding 10 percent of this material to the standard ethylene dichloride-carbon tetrachloride mixture excellent results were obtained with a saving of 4 gallons of fumigant per 1,000 bushels of grain. This new and economical mixture was at once adopted and used on a large scale for fumigation of Ever-Normal Granary corn in steel bins.

In a search for methods of protecting fumigated corn in steel bins from reinfestation, it was found that refined light mineral oil applied to the surface layer at the rate of 2 quarts per 1,000 bushels of grain largely prevented reinfestation by the Indian-meal moth and many other insects.

THE CHINCH BUG

Owing to a warm, dry fall in 1941 the chinch bug again entered hibernation in threatening numbers in eastern Kansas and Nebraska and in southwestern Iowa. As war conditions had diverted the principal supplies of standard coal-tar creosote to other uses, it was feared that the supply for chinch bug barriers would be insufficient. Tests of a number of possible substitutes were therefore begun early in 1942. Among the promising chemicals were dinitroorthocresol combined with a dust carrier, and certain tar oils and similar compounds that are byproducts of industrial processes.

THE SUGARCANE BORER

Favorable results were obtained in 1941 from tests with cryolite dust for the control of the sugarcane borer. When applied four times at weekly intervals during the early instars of the first generation 98 to 99.5 percent mortality was obtained. Cryolite alone or diluted with 20 percent of inert carrier seemed equally effective. In view of these excellent results, arrangements were made with commercial growers for dusting about 800 acres of sugarcane in the early summer of 1942, and these operations appear to have been highly successful. As the sugarcane borer is an important factor in the production of cane sugar in Louisiana, its successful control is a matter of much concern because of the sugar shortage due to war conditions.

WHITE-FRINGED BEETLE CONTROL AND ERADICATION

White-fringed beetles were found in several localities in the vicinity of known infestations in Alabama, Florida, Louisiana, and Mississippi. The quarantine was revised, effective May 9, 1942, to extend the regulated areas to include these localities and to release a small area no longer found infested. The known infested areas total less than 100,000 acres. All ports of entry from Charleston, S. C., to Corpus Christi, Tex., were scouted, cooperatively with the States, with negative results. Suppressive measures were conducted in all areas in which there existed danger of spread of infestation, and eradication measures were applied to five selected areas of varying type and intensity of infestation, resulting in apparent elimination of the pests in three. Restrictions as to certification of nursery stock were lessened by modifying the treatment requirements as indicated by investigational work.

Beetle populations in the spring of 1942 remained low except in a few areas, including the vicinity of Florala, Ala., where larval damage occurred over a wider area than in previous years.

All lines of activity were conducted jointly with the pest-control officials of the affected States.

MORMON CRICKET CONTROL

The Bureau cooperated in Mormon cricket control work in eight Western States. Federal emergency funds were expended principally on Government-owned lands and adjacent areas. Federal agencies participating in work on lands controlled by them were the Office of Indian Affairs and the Grazing Service of the Department of the Interior and the Forest Service of the Department of Agriculture. Elsewhere State and municipal offices and private individuals cooperated.

Infestation in the spring of 1942 involved 7,500,000 acres, as shown by the preceding fall survey. Control consisted in spreading 1,448 tons of sodium fluosilicate bait over 303,014 acres, and dusting 13 tons of sodium arsenite over 6,156 acres. The effectiveness of the bait greatly reduced the amount of oil-on-water barrier necessary. Bait was applied by aircraft, by power and traction spreaders, and by hand. Dust was applied by power dusters. Reports on crop losses due to Mormon crickets came from only a few farm gardens.

GRASSHOPPER CONTROL

Bureau participation in control of grasshoppers during 1942 had been planned for 12 States wherein surveys indicated the prospective need. Subsequent developments broadened the area to include 8 additional States, but the increased geographical range of activity was offset in part by the use of less bait than was anticipated, because persistent moisture conditions in the northern Great Plains and Central States promoted heavy growth of field crops and native vegetation.

Control was primarily on a voluntary basis, but in several instances wartime limitations on cooperators, affecting the use of their equipment, necessitated amplification of the Bureau's effort. Voluntary grasshopper control was conducted on an unusually large proportion of range land, principally in southeastern Arizona, the interest of private individuals having been stimulated by the current high price

of cattle. Much of the range baiting in Arizona was done by State-hired aircraft, which spread 1,088 tons of bait over 120,640 acres. Sodium fluosilicate bait was substituted for sodium arsenite in the Southwestern States, where it was used widely and successfully. The scope of control activity in this region embraced extensive crop areas in Texas and New Mexico, crop and range land in Arizona and New Mexico, and crops and Federal experimental plantings of guayule in southern California.

In the States using the most bait the quantities were the following: Texas, 13,158 tons; Arizona, 2,877 tons; and California, 1,274 tons.

CHINCH BUG CONTROL

Surveys showed potential chinch bug infestations for 1942 threatening crops in 7 States. Creosote, the principal control material, is much in demand for war purposes. The Bureau anticipated purchases and deliveries by installing 22 converted oil-storage tanks strategically located in Kansas and Nebraska. Since drums were unavailable, this plan permitted the economical purchase and prompt delivery of creosote in carload lots, with consequent savings more than sufficient to pay for the storage tanks.

Large-scale field experiments employing dinitroorthocresol dust were conducted in six States. All demands for control materials were promptly met. Rains reduced infestations in several areas. During 1942, 61,100 pounds of dinitroorthocresol dust and 368,000 gallons of creosote were purchased with emergency funds and made available to infested States.

ARMYWORM CONTROL

States requesting aid to control armyworms were promptly supplied with bait materials purchased from emergency funds.

EUROPEAN CORN BORER INSPECTION AND CERTIFICATION

Inability of the Bureau to carry on an adequate system of European corn borer inspection and certification with the appropriation of \$10,000 allotted made it necessary to discontinue this service on December 31. During the period when the project was operative 10,389 shipments of quarantined plant material having an estimated value of \$117,000 were certified. Before the project was discontinued the Bureau obtained assurance from all States which had theretofore required Federal inspection that their State corn borer quarantines and orders would be so amended as to provide for the acceptance of certification in lieu of the Federal certification previously demanded. The burden of supplying corn borer certification for interstate shipments from infested areas now rests with the State of origin.

BARBERRY ERADICATION

PRESENT STATUS OF BARBERRY-ERADICATION PROGRAM

Since 1918 more than 300,000,000 rust-susceptible barberry bushes have been destroyed on 111,987 properties in 17 of the more important

grain-growing States. In this area stem-rust losses have been reduced by approximately 60 percent. This represents an annual estimated savings to grain growers of about \$25,000,000. The 17 cooperating States produce annually approximately 1,420,277,000 bushels of wheat, oats, barley, and rye. When rust develops to general epidemic proportions, this disease destroys hundreds of millions of bushels of grain during a single season. Local epidemics of stem rust have been eliminated except where rust-susceptible barberry bushes still remain in the eradication area. These local outbreaks were a common occurrence when the area was generally infested with barberries, and every year these bushes were important early sources of stem rust.

Since 1935 this project has been financed largely with emergency relief funds allotted to the Department. These allotments were terminated December 31, 1941. During the last half of the fiscal year Bureau-sponsored State WPA projects provided for a limited barberry-eradication program in some States, but labor was not available from this source in many of the important grain-producing areas infested with fruiting barberry bushes. Experience shows that surveys in these areas are necessary at intervals of from 4 to 6 years, until there no longer is danger of new plants developing from seeds in the soil.

PROGRESS IN BARBERRY ERADICATION

Progress during the year was somewhat less than in the previous year, owing to a reduction in the amount of available labor. However, 21,957,121 barberry bushes were destroyed on 1,960 new and 2,047 resurvey properties in 196 counties. An additional 6,730 properties, previously infested, were reinspected, and on these no bushes were found. A total of 29,347 square miles of territory were surveyed, of which 9,461 represented subsequent survey in heavily infested territory. Of the total number of bushes destroyed this year, 21,181,399 were the native species *Berberis canadensis* and *B. fendleri*. The former species is found only in Virginia and West Virginia, and in limited areas in Illinois, Iowa, and Missouri. *B. fendleri* is restricted to southwestern Colorado. These native species are as susceptible to stem rust as the common barberry, *B. vulgaris*. A summary of eradication work by States is shown in table 3.

In carrying out this work the State, county, and local agencies, as well as farm operators, continued to cooperate. In addition to direct aid in the form of cash allotments, they provided trucks, labor, and equipment for the eradication of bushes on farm properties; clerical, technical, and regulatory service; office, greenhouse, laboratory, and storage space; and miscellaneous supplies, including chemicals for treating barberry bushes.

Since emergency relief labor was not available for resurvey work in many barberry-infested areas in important grain-producing counties, it was necessary to carry on initial surveys in less important territory where labor could be obtained. Much of this area was heavily wooded, and consequently it was worked by a modified survey method which has been found effective in this kind of territory.

TABLE 3.—Progress in barberry eradication, fiscal year 1942

State	Extent of survey	Properties cleared		Bushes destroyed		Salt used
		New	Old	<i>Berberis vulgaris</i>	Native species	
	<i>Square miles</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Tons</i>
Colorado.....	429	27	133	60	3,400,310	0.47
Illinois.....	2,371	96	105	1,095	-----	2.6850
Indiana.....	1,818	46	81	1,841	-----	1.881
Iowa.....	2,948	259	243	12,786	-----	25.464
Michigan.....	2,999	163	148	3,953	-----	15.77
Minnesota.....	4,725	94	64	2,238	-----	10.151
Montana.....	38	32	17	212	-----	.612
Nebraska.....	1,535	5	19	78	-----	.0625
North Dakota.....	4,973	4	6	108	-----	.29
Ohio.....	770	41	56	2,292	-----	4.98
South Dakota.....	238	2	1	20	-----	.1
Wisconsin.....	1,833	296	299	12,650	-----	34.0185
Wyoming.....	0	0	0	0	-----	0
Total.....	24,677	1,065	1,172	37,333	3,400,310	96.4840
Missouri.....	2,830	36	9	366	-----	.6725
Pennsylvania.....	1,481	549	746	738,017	-----	317.11
Virginia.....	235	277	31	2	8,048,681	480.6635
West Virginia.....	124	33	89	4	9,732,408	370.2915
Total.....	4,670	895	875	738,389	17,781,089	1,168.7375
Grand total.....	29,347	1,960	2,047	775,722	21,181,399	1,265.2215

NURSERY INSPECTION FOR SUSCEPTIBLE BARBERRIES

Susceptible barberry bushes are gradually being removed from all nurseries within the States protected by the black stem rust quarantine. In 1941, 726 susceptible plants were destroyed, as compared with 23,750 in 1938. The nursery-inspection work is changing the commercial demand for barberries to immune species and bringing about a substantial reduction in the number of susceptible plants grown in nurseries even outside the protected area.

During the year 49 nurseries applied for permits to ship immune species of *Berberis* and *Mahonia*, other than *B. thunbergii*, into the States protected by the quarantine. These nurseries were inspected and permits were issued to 45 applicants; 2 were refused, where susceptible plants were found on their properties; and the other 2 were found not to need permits since they were growing only *B. thunbergii*.

STEM RUST SPREAD AND DAMAGE IN 1941

The loss caused by stem rust in 1941 was not of great importance. Considerable damage resulted to susceptible soft winter wheats, particularly in northern Texas and north-central Oklahoma. The only appreciable loss in Kansas occurred in a small area near Liberal, in the southwestern part of the State. In Missouri damage was confined to fields of soft wheat in the western part of the State, along the Missouri River. There were some local epidemics in other States, especially near barberries in Colorado, Pennsylvania, Virginia, and West Virginia. Stem rust caused little loss to spring wheat, and the aggregate damage to oats was not appreciable.

Barberry bushes rusted in 16 States, but in certain areas in northern Michigan and southwestern Colorado there was less infection

than in preceding years. The rust spread to spring wheat from heavily infected native barberries in La Plata and Archuleta Counties, Colo., causing severe damage in some fields.

PREVALENCE OF PHYSIOLOGIC RACES

Of particular interest in the physiologic-race surveys is the fact that race 56 was surpassed in prevalence for the first time in 7 years. Race 17, which has been increasing noticeably since 1939, exceeded race 56 in 1941, both in northern Mexico and in the United States. Only 30 percent of the aecial collections obtained in 1941 were suitable for varietal determinations. From the 91 viable collections 104 isolates were made, of which 69 were *Puccinia graminis tritici* (wheat-stem rust), 20 were *P. graminis secalis* (rye-stem rust), and 15 were *P. graminis avenae* (oat-stem rust). From 804 collections of stem rust on wheat, 1,270 isolates comprising 12 races were identified, or a different race for every 67 collections from grain. From 69 aecial collections 103 isolates comprising 15 races were identified, resulting in a different race for every 4.6 collections from barberries. The higher ratio of races from barberry, in comparison with that from grains and grasses, emphasizes the importance of barberry eradication as a means of reducing the development and prevalence of physiologic races.

BARBERRY-SUSCEPTIBILITY TESTS

More than 400 plants of barberry species and varieties were tested for susceptibility to stem rust. Infection occurred on 93 percent of the plants, varying in severity from single pycnia to infection so abundant as to include the entire leaf surface. The results of these greenhouse and outdoor tests did not change the list of species or varieties immune to attack but confirmed the susceptibility of some doubtful species.

TRUCK CROP AND GARDEN INSECT INVESTIGATIONS

The importance of insect damage as a factor limiting the maximum production of vegetable crops to meet wartime needs was early recognized. Therefore, under each of the Division's projects such changes were made in the objective and plan of work as would provide the most immediate benefit, with emphasis on the formulation of control recommendations. Extensive experiments were initiated to explore the possible utility of some of the insecticides that have recently been developed by this Bureau or other agencies as substitutes for materials made scarce by wartime conditions, and also to investigate thoroughly other methods of insect control.

VEGETABLE INSECTS

New work was undertaken in the State of Washington, in cooperation with the Division of Cereal and Forage Insect Investigations of this Bureau and with State officials, to determine the distribution, habits, and control of the recently introduced European pea weevil (*Sitona lineatus* (L.)), which has been injuring peas, vetch, clover, and alfalfa.

The need for more accurate information on the distribution and status of the potato tuber worm has long been felt, especially as to whether the pest is actually established in certain areas or is only present temporarily as a result of infested potatoes being shipped in from other areas. In recognition of this need the Division has initiated a survey in cooperation with other Divisions of the Bureau and officials of 17 States. It is hoped that this survey may ultimately be extended to include all the States where the presence of this insect is known or suspected.

To aid growers of vegetable crops in Florida in the control of mole crickets, the Division has continued to cooperate with the Division of Domestic Plant Quarantines of this Bureau and with the State Plant Board of Florida in experiments to perfect the large-scale control program against these pests. These experiments disclosed differences in the development and reactions of the various species of mole crickets present in infested areas, which may have a pronounced effect upon the recommended control measures, but more information is needed regarding the habits of each species before the most effective control methods can be developed. It has been shown that the southern mole cricket is much less susceptible to the calcium arsenate baits, heretofore widely used in control operations, than the changa; sodium fluosilicate appears to be a satisfactory poison in the bait for both species; no commonly available substance is more satisfactory as a carrier than wheat bran; meat scrap is the only material tested that shows promise as an added attractant; and mole cricket damage to transplanted plants is dependent on many factors as yet unknown.

Tests of different materials as substitutes for derris, cube, or timbo against the pea weevil have thus far been unsuccessful, although some indications have been obtained that pyrethrum, as well as certain of the dinitro compounds, may be useful.

In experiments on the control of aphids affecting potatoes in Maine, derris combined with bordeaux mixture and insoluble copper sprays and dusts reduced the population of aphids, increased the yield of potatoes, and decreased the incidence of net necrosis and leaf roll disease. Although these results were promising, the degree of control of the insect-borne leaf roll disease was not satisfactory. The discovery that at least eight species of weeds occurring commonly in potato districts of northern Maine serve as wild breeding hosts of aphids infesting potatoes indicates the necessity of eliminating or greatly reducing the abundance of these weeds.

Information to serve as the basis of control experiments was obtained on the seasonal occurrence and development, duration of stages, and host plants of potato flea beetles in the Pacific Northwest. Field experiments demonstrated that the most effective material against these insects was calcium arsenate dust, but dusts containing zinc arsenite and some of the fluorine and rotenone compounds gave fairly good control following eight applications.

As an aid to the stimulation of the victory-garden program, a bulletin has been prepared on insecticides and equipment used in combating the principal pests attacking vegetables, fruits, andamentals.

SUGAR BEET INSECTS

Investigations of insects affecting sugar beets have been continued in Idaho, Utah, Arizona, and California. The biological phases have dealt primarily with the importance of various wild plants as hosts of the beet leafhopper, such information being of value in connection with range-rehabilitation or land-planning programs.

In preliminary field tests in southern Idaho for control of the beet leafhopper on sugar beets grown for sugar, encouraging results were obtained with dry and liquid lime-sulfur and micronized wettable sulfur in combination with water-soluble pyrethrum extract, and also with a pyrethrum-oil spray.

The first direct evidence regarding the long-distance movements of the beet leafhopper in California was obtained from field experiments with marked individuals, which were recovered at a maximum distance of approximately 10 miles from the point of liberation. By following this technique it will be possible to determine more accurately the movements of beet leafhoppers from wild-land breeding areas to cultivated crops and return, and thus locate the areas of wild host plants against which control measures should be instituted.

Since the domestic production of sugar beet seed has assumed increased importance, special attention has been devoted to the control of insects affecting this crop. In New Mexico pyrethrum-oil treatments have increased the yield of viable seed produced in fields. Field tests in Arizona and Oregon against several species of *Lygus* plant bugs disclosed that a dust mixture of an "impregnated" pyrethrum powder, sulfur, and pyrophyllite applied at a time when the adults and nymphs were abundant on the seedstalks constituted an effective remedy. Experiments in Arizona demonstrated that plants with seedstalks of an average length of 2 inches at the time of infestation were much more susceptible to curly top disease than beets with an average seedstalk length of 15 inches. These results indicate the importance of using such cultural methods as will hasten the development of the seedstalk in the spring to the point where it will be at an advanced stage before the influx of leafhoppers.

TOBACCO INSECTS

Field tests in South Carolina showed that sprays containing cryolite or lead arsenate were effective against tobacco hornworms infesting flue-cured tobacco. Three to five applications were necessary for an early or midseason crop, and five or six for a late-season crop. A simple and efficient adjustable spray boom was developed for use with traction sprayers. Cryolite sprays did not control tobacco hornworms on tobacco of the dark fire-cured or burley type in Tennessee, or on the shade-grown type of tobacco in Florida.

Experiments in Virginia showed that the new type of tight hogshead that has been developed by the industry afforded only slight protection of stored tobacco against the cigarette beetle although it gave considerable protection against the tobacco moth. The use of paper liners in the old-type hogsheads gave a high degree of protection against both species. Experiments with tobacco in cold storage showed that temperatures of 60° to 65° F. prevented damage by the cigarette beetle and the tobacco moth.

INSECTS AFFECTING GREENHOUSE AND ORNAMENTAL PLANTS
AND MUSHROOMS

The investigations on insects affecting greenhouse and ornamental plants and mushrooms were reorganized early in the year to meet the need for intensifying the work on insecticides. Work on mushroom pests was discontinued, and this activity is now concerned principally with testing and developing insecticides similar to those used on crops grown out of doors, particularly against such pests as aphids, leafhoppers, thrips, mealybugs, red spiders, and other mites. Studies on insect carriers of disease of greenhouse crops and bulbs are being continued.

SWEETPOTATO WEEVIL CONTROL AND ERADICATION

Federal-State operations for control and eradication of the sweet-potato weevil were continued in Alabama, Georgia, Mississippi, and Texas, and in June 1942 a survey was begun in seven Louisiana parishes adjacent to the infested area in Mississippi. Eradication was apparently accomplished throughout the Mississippi counties of George, Pike, and Walthall, and on approximately 650 properties in Alabama, Georgia, Mississippi, and Texas. Eradication measures were begun in the Texas counties of Angelina, San Augustine, and Sabine, with the aim of protecting the commercially producing counties immediately to the north, from which the weevils apparently have been eliminated, and also in Brooks County, Ga., where infestations were discovered in the spring of 1942.

Outside the eradication areas, comprised of 17 counties in Alabama, Georgia, Mississippi, and Texas, inspections were made in 32 counties, and infestations were discovered in 2 of them. These 2 counties were then included in the eradication areas.

MOLE CRICKET CONTROL

Mole cricket populations in several Florida counties reached epidemic proportions early in the summer of 1941. The growers appealed for aid, a survey was made, and the Bureau provided supervision and technical assistance and poisoned-bait ingredients to State agencies for distribution to counties. During the fall more than 2,200,000 pounds of mixed bait were furnished to growers in 11 counties.

COTTON INSECT INVESTIGATIONS

THE BOLL WEEVIL

The damage caused by the boll weevil in 1941 was estimated at 15.4 percent of the cotton crop—the most severe loss since 1927 and about double that in each of the previous 2 years. The damage was particularly heavy in the eastern and central sections of the Cotton Belt, with 27 percent in South Carolina and Georgia, 19 percent in Florida, 20 percent in Alabama, 23 percent in Mississippi, and 22 percent in Louisiana. The large numbers of weevils entering hibernation in 1940, the high survival, delayed emergence, and late crop of 1941, together with the shortage of calcium arsenate and dusting machinery, were responsible for the increased damage. Although

large numbers of weevils entered hibernation in the fall of 1941, the survival in cages was very low following the winter, with an emergence of 1.1 percent at Florence, S. C., 2.0 percent at Tifton, Ga., 12.4 percent at McIntosh, Fla., 0.14 percent at Tallulah, La., and 0.19 percent at Waco, Tex. The weather in 1942 tended to check weevil development and caused early maturity of the crop, so that at the end of June it appeared that the damage would be much less than in 1941.

The average gain in plots dusted with calcium arsenate at Tallulah, La., in 1941 was 455 pounds of seed cotton per acre, or 46.3 percent, as compared with a 22-year average of 323 pounds, or 24.1 percent. At Florence, S. C., the average gain was 571 pounds of seed cotton per acre, or 132 percent, over the undusted plots, and at Waco, Tex., 341 pounds per acre. The aphid populations were heavy at all localities and considerably reduced the potential gains from calcium arsenate dusting. Mixtures of calcium arsenate and sulfur, 1:1 or 1:2, gave gains twice those given by calcium arsenate at Waco and were about as effective as calcium arsenate at State College, Miss., and Florence, S. C.

The experiments at Tallulah comparing the efficacy of applications of calcium arsenate at different times of day confirmed previous results that dusting during the day when the plants were dry would give good control. Under the heavy weevil infestations of 1941, early-morning applications gave an increase of 420 pounds of seed cotton per acre, midday applications 459 pounds, and late-afternoon applications 429 pounds. Over the 6 years that the experiments have been conducted the average gains were 309, 311, and 265 pounds, respectively. On the basis of these tests under varying degrees of weevil intensity, the Bureau now recommends that dusting be done at any time of day or night when the air is calm, regardless of whether the plants are wet with dew. Other tests have shown that it is safe, and often more profitable, to delay dusting cotton growing on fertile soil that will continue to fruit until late in the season until 20 to 25 percent of the squares are punctured, instead of beginning at the 10-percent infestation level as previously recommended. These changes in recommendations reduce the cost of weevil control by saving one or two applications, conserving insecticides, and enabling growers to dust larger acreages with the same machinery.

COTTON APHIDS

Means of checking the increase in cotton aphids following the use of calcium arsenate for control of the boll weevil and other insects has become one of the most pressing and difficult problems in cotton-insect control. Investigations were continued along three lines: (1) Causes of aphid increase, (2) materials to be added to calcium arsenate to prevent aphid build-up, and (3) development of cotton resistant to aphids. Studies of the physiological changes in the plant by absorption of calcium arsenate showed that neutral calcium arsenate caused less increase in aphids than the commercial basic calcium arsenate. The addition of zinc or iron salts to calcium arsenate in the dry state neutralized the basic salt temporarily, but upon standing its reaction reverted to alkaline. The "zinc-safened" calcium arsenate produced commercially as a result of these investigations caused fewer aphids

to develop than regular calcium arsenate, although the populations became sufficiently heavy late in the season to cause damage in field tests. Part of the effect from the zinc-safened calcium arsenate was apparently due to stimulation of the plants by the zinc. Applications of arsenicals accelerated plant maturity and increased leaf drop on all varieties of cotton but especially on early-maturing varieties.

It was also found that where calcium arsenate was used nitrogenous fertilizer applied to cotton at planting caused aphids to increase in direct proportion to the nitrogen content but caused no appreciable aphid increase on undusted cotton.

In a large series of tests at seven localities the addition of small quantities of rotenone (derris or cube) or nicotine to calcium arsenate held the aphid populations near the level of the untreated checks during the dusting period and caused significant increases in yield. In some experiments, however, the aphids increased to injurious numbers after applications were stopped and before the crop matured. One-half percent of rotenone added to calcium arsenate and 0.25 percent of rotenone added to a 1:1 mixture of calcium arsenate and sulfur were about equally effective, but smaller amounts were not satisfactory. One percent of nicotine added to the calcium arsenate used for each application or 2 percent for alternate applications was in general more effective in holding down the aphids than 0.5 percent of rotenone. The gains from calcium arsenate plus derris or nicotine were twice those from calcium arsenate alone in some experiments and illustrate the serious losses caused by aphids.

In tests on varietal resistance of cotton to aphids, although no plants or strains have been found that are immune, selections have been made showing variations in susceptibility. Aphid tolerance is associated with poor fruiting qualities and is further complicated because some strains are attacked early and are practically free from aphids later in the season. Two selections for aphid tolerance are sufficiently promising to be tested under field conditions this year.

THE BOLLWORM

The severe outbreak of bollworms in all parts of the Cotton Belt and the difficulties of control experienced by farmers emphasize the need for more practical and effective methods. The arsenical and fluorine insecticides give fair control of the small larvae before they enter the bolls or squares, but they do not kill larger larvae. The insecticide should be applied just as the eggs are hatching, but most farmers wait until the worms are actually damaging the crop and then obtain poor control.

In tests at Waco, Tex., plots dusted with basic copper arsenate for combined control of the boll weevil and bollworm produced 1,530 pounds of seed cotton per acre, with zinc-safened calcium arsenate 1,393 pounds, and with calcium arsenate 1,216 pounds, as compared with 781 pounds in the untreated plots. Basic copper arsenate was more toxic to the larger worms than any material used in cage tests, and it was also effective against the boll weevil and the cotton flea hopper.

Evidence is accumulating that the increase of aphids following the use of arsenicals is intensifying bollworm injury (1) by attracting ovipositing moths to the honeydew secreted by the aphids, (2)

by killing the predators, and (3) by reducing the number of bollworm eggs and young worms destroyed by individual predators because the predators feed on the aphids instead of the bollworm eggs and larvae. Approximately 1,200 *Paratriphleps laeviusculus* Champ., a predator of the bollworm, were imported from Peru and released near Brownsville, Tex.

THE PINK BOLLWORM

In the lower Rio Grande Valley investigations of the pink bollworm centered on the seasonal abundance, how and where the winter is passed, host plants, and other studies of immediate aid in the control program. The early-season population was light, averaging only one larva to 122,545 squares and blooms inspected, but late in the season pink bollworms were more abundant than in 1940. Heavy rainfall and overflow from the Rio Grande delayed the fall clean-up and caused cotton to continue fruiting late in the season, the result being a heavier carry-over into 1942. Larvae in cages survived from September to May in open, dry bolls on the soil surface, such as are found in crop debris. In green cotton, larvae were found developing in bolls in all months of the year except February and March. Larvae were also found in green and dry okra pods during the fall and winter, and one larva was found in *Malvaviscus drummondii*. The fact that the pink bollworm continues to breed during the winter if hosts are available emphasizes the importance of field clean-up in the lower Valley. The survival of inactive larvae from one crop season to another also adds to the difficulty of eradication. No larvae have been found hibernating in cocoons in the soil such as occur in the drier areas.

Practically the entire cotton acreage in the Big Bend of Texas was planted to the quick-maturing eastern varieties introduced by this Division. The average yields of these varieties were 1,493 pounds of seed cotton per acre as compared with 890 pounds for the variety formerly grown. The improved cultural practices developed for use under local pink bollworm conditions and the quick-maturing varieties permit earlier harvesting and fall clean-up of fields, which reduces the carry-over of hibernating larvae.

In further tests with the addition of oil and nicotine to cryolite, the results were not so satisfactory under field conditions as in previous laboratory and cage tests. Sweetened baits containing several toxic materials all gave some kill of moths in cage tests. Several synthetic organic insecticides gave fair reduction of larvae in cage tests.

HEMIPTEROUS INSECTS

Airplane-dusting experiments for control of plant bugs and stink bugs with a mixture of sulfur and paris green were continued in cooperation with Arizona cotton growers to obtain more definite information on the economic value of large-scale operations. The insect populations were not so large in the test fields and the profits were not so great as in 1940, but the increased yields of cotton and the improvement in grades more than paid for the cost of treatment. As a result of these investigations 40,000 acres of cotton were dusted by airplane with more than a million pounds of insecticide in 1941. The

extensive use of the control method developed by the Bureau is helping to meet the Department's production goal of long-staple cotton and maintain the high quality of lint needed for military purposes.

RELATION TO PRODUCTION GOALS AND THE WAR PROGRAM

The importance of protecting cotton from insect damage has been greatly increased by the war. Cotton is a vitally necessary commodity for food, feed, fiber, and munitions. More oil is needed to replace vegetable oils formerly imported; more cottonseed meal is required for producing larger quantities of milk, butter, and meats for our allies; and additional lint and linters are necessary to supply the many articles of clothing, equipment, and munitions for the military.

Development of control measures is thus directly related to the war effort, and shifts in emphasis have been made to phases that are of most immediate value. Owing to exceptionally heavy insect infestations, the amount of calcium arsenate used was increased from about 35 million pounds in 1940 to 71 million pounds in 1941, with corresponding increases in the use of sulfur and other insecticides. Consequently, many requests for assistance came from growers unfamiliar with methods of application and dosages. The shortage of arsenical insecticides and dusting machinery generally used for cotton-insect control increased the requests for information on substitutes. Interest in this type of information was manifested by attendance of more than 500 people at some of the meetings of county agents, farmers, and others, and visits of about 1,200 people to some of the experimental plots. Members of the Division participated in two conferences to coordinate the efforts of the various State and Federal agencies on boll weevil control and in several meetings to train county and State leaders in control of cotton insects.

Small stocks of insecticides were carried forward into 1942, and the manufacturers were unable to supply the demand for calcium arsenate early in the season. Information on cotton-insect conditions was furnished the Office for Agricultural War Relations as a guide in distributing the available supply of calcium arsenate to the areas where it was most needed. Owing to the possible curtailment in production of arsenical insecticides in 1943, the reduction in imports of derris, and the shortage of dusting machinery, investigations have been undertaken on substitutes, reduced dosages, and other methods of securing the maximum benefits from the available supplies.

PINK BOLLWORM CONTROL AND QUARANTINE ENFORCEMENT

Inspection of the 1941 cotton crop revealed that for the second consecutive season no new areas had been invaded by the pink bollworm. The regulated area as a whole showed a decrease in infestation, and in a number of counties infested in 1940 no infestation was found. Decrease in infestation was outstanding in southern Texas, where a control program is carried on each year following the harvesting of about 425,000 acres of cotton. In the Big Bend area of Texas and Mexico the infestation remained at approximately the same level as in 1939 and 1940.

There was a scarcity of manpower in wild-cotton eradication work in Florida, but the area was in a satisfactory condition at the close of the season.

CONTROL PROGRAMS IN THE VARIOUS REGULATED AREAS

Individual farmers in the lower Rio Grande Valley and coastal bend areas of Texas were unable to complete the clean-up of fields in 1941 as early as usual. The Bureau, in cooperation with Texas authorities, grubbed sprout and volunteer plants from approximately 111,000 acres, but owing to the delay in grubbing, and consequently in the establishment of a host-free period, the pest was able to breed late in the season.

The cooperative control program undertaken by the United States and Mexico in the Big Bend of Texas, by which planting of cotton is delayed and stalks of debris are burned in the fall, has aided in reducing the pink bollworm population from an average of 212,000 to the acre in 1937 to 1,600 in 1941. This year additional emphasis was placed upon deep plowing and winter irrigation.

The infestation near Glendale, Ariz., showed increase in intensity and in area affected. Farmers were able to destroy stalks on approximately 10,000 acres, 1,000 acres of which were infested. This entire acreage was plowed to a depth of from 6 to 8 inches and then irrigated.

ENFORCEMENT OF QUARANTINE REGULATIONS

A total of 868,203 bales of cotton were produced at the 538 gins within regulated areas in Texas, New Mexico, and Arizona. A total of 390,740 tons of seed were sterilized, and 3,839 bales of lint produced in areas most heavily infested were treated by being passed between heavy steel rollers. At the 48 oil mills 341,686 tons of seed were received and processed and 11,970 bales of linters were roller-treated, and at the 15 compression plants lint amounting to 643,026 bales and 16,282 bales of linters were compressed.

More than 1,000 trucks leaving the Panhandle district of western Texas were examined, and many of them were found to be fouled with unsterilized cottonseed. In southern Texas 1,300 small lots of seed cotton and cottonseed being carried by cotton pickers were confiscated through examination of 1,600 cotton-pick sacks.

Gin-trash inspection in the regulated areas in southern Texas showed a marked decrease in infestation. Results were negative in all the Panhandle except Terry County, where two pink bollworms were found, as compared with findings in four counties in 1940. Infestation in the Pecos Valley of Texas and New Mexico decreased; however, in El Paso County in Texas there was a local increase. The reduction in infestation accomplished in the Big Bend of Texas in 1939 continued to be maintained. In the Safford Valley of Arizona there was no significant change.

The amount and results of the various types of inspection are summarized in table 4.

Inspections outside the regulated areas were made in 30 counties in Alabama, 19 in Arkansas, 7 in California, 10 in Florida, 73 in Georgia, 17 in Louisiana, 70 in Mississippi, 17 in Oklahoma, 8 in Tennessee, and 105 in the nonregulated portions of Texas. A total of 25,832 bushels of trash were examined in States other than Texas and 37,823 bushels in Texas. All the cotton-growing areas in Mexico were given a satisfactory inspection in cooperation with the Mexican Government. To supplement gin-trash inspection in the United

States green bolls were collected and preserved for later laboratory examination.

A summary of the amount and the results of the various kinds of inspection is given in table 5. (See p. 44.)

TABLE 4.—Summary of inspections for the pink bollworm in regulated areas, crop season of 1941

State	Gin trash		Field				Laboratory ¹	
	Quantity	Pink boll-worms	Squares	Blooms	Bolls	Pink boll-worms	Green bolls	Pink boll-worms
	<i>Bushels</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
Arizona.....	16, 507	724	0	2, 925	275	² 32	0	0
New Mexico.....	1, 207¼	176	0	0	0	0	10, 873	5
Texas.....	47, 061¼	5, 917	0	³ 166, 815	⁴ 350	⁵ 9	12, 688	63
Total.....	64, 775½	6, 817	0	169, 740	625	41	23, 561	68

¹ Laboratory inspection covers bolls collected from 1940 cotton crop.
² Found through incidental inspections in the Glendale area.
³ Inspected in lower Rio Grande Valley, with negative results.
⁴ Inspected in Reeves County, with negative results.
⁵ Taken from an unrecorded number of bolls at El Indio in Maverick County.

COOPERATIVE PINK BOLLWORM WORK IN MEXICO

Cooperation in combating the pink bollworm has long existed between the United States and Mexico. In 1938 new cooperative control measures were inaugurated, whereupon the unified plans formulated by agricultural officials of the two countries were translated into action in such a manner as to bring about more effective results. The pink bollworm is present in all of Mexico adjacent to Texas and in the border areas of the United States from the lower Rio Grande Valley of Texas to Arizona. The infested areas of Mexico are now divided into seven districts, with an officer in charge of each district. Quarantine requirements are similar, and plans of control are formulated and carried out cooperatively by the two countries. In the lower Rio Grande Valley of Mexico farmers destroyed stalks on approximately 200,000 acres following the harvesting of the 1941 cotton crop. A cooperative control program has been in effect in the Big Bend of Texas and Mexico since 1938, with very satisfactory results, and a similar program is in effect in the El Paso and Juarez Valleys.

WILD-COTTON ERADICATION

The eradication of wild cotton in southern Florida was continued as a Federal WPA and Bureau project until January, when a State WPA project superseded the Federal project, the WPA furnishing labor only. During the season closing in June a total of 13,735 plants with mature bolls, 703 sprout plants, and 864,610 seedlings were removed from the approximately 16,000 acres of wild cotton. An increase of 180,000 seedling plants over the number destroyed the previous season is attributed to an unusual amount of rainfall at a period favorable for germination of dormant seed. Scouting outside of known wild-cotton locations this season resulted in 303 mature plants and 447 seedlings being removed from a total of 5 acres at several points.

TABLE 5.—Summary of inspections for the pink bollworm outside regulated areas, crop season of 1941

State	Gin trash		Field		Field material
	Quantity	Pink boll-worms	Labor	Pink boll-worms	Squares
	<i>Bushels</i>	<i>Number</i>	<i>Man-days</i>	<i>Number</i>	<i>Number</i>
Alabama.....	2,933	0	0	0	0
Arizona.....	41	0	0	0	0
Arkansas.....	2,244	0	0	0	0
California.....	4,499	0	0	0	0
Florida.....	407½	0	28	0	5,917
Georgia.....	4,744½	0	1	0	0
Louisiana.....	1,745½	0	0	0	0
Mississippi.....	3,877	0	0	0	0
New Mexico.....	0	0	0	0	0
Oklahoma.....	5,019	0	0	0	0
Tennessee.....	322	0	0	0	0
Texas.....	37,823¼	0	0	0	0
Total.....	63,655½	0	29	0	5,917
Mexico:					
Baja California.....	644	0	0	0	0
Chihuahua.....	92¾	28,896	0	0	0
Coahuila.....	34	0	0	0	0
Nuevo Leon.....	731	1	0	0	0
Sinaloa.....	283	0	0	0	0
Sonora.....	39	0	0	0	0
Tamaulipas.....	1,946½	297	0	0	0
Total.....	3,770¼	29,194	0	0	0
Grand total.....	67,425¾	29,194	29	0	5,917

State	Field material			Laboratory ¹	
	Blooms	Bolls	Pink boll-worms	Green bolls	Pink boll-worms
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
Alabama.....	0	0	0	0	0
Arizona.....	0	0	0	0	0
Arkansas.....	0	0	0	0	0
California.....	0	0	0	0	0
Florida.....	1,857	51,263	360	38,168	317
Georgia.....	0	350	0	0	0
Louisiana.....	0	0	0	0	0
Mississippi.....	0	0	0	0	0
New Mexico.....	0	0	0	4,270	0
Oklahoma.....	0	0	0	0	0
Tennessee.....	0	0	0	0	0
Texas.....	0	0	0	192,858	0
Total.....	1,857	51,613	60	235,296	17
Mexico:					
Baja California.....	0	0	0	0	0
Chihuahua.....	0	1,000	130	0	0
Coahuila.....	0	0	0	0	0
Nuevo Leon.....	0	0	0	0	0
Sinaloa.....	0	0	0	0	0
Sonora.....	0	0	0	0	0
Tamaulipas.....	281,872	0	2	0	0
Total.....	281,872	1,000	132	0	0
Grand total.....	283,729	52,613	192	235,296	17

¹ Laboratory inspection covers bolls collected from 1940 cotton crop.² Sea-island cotton.³ Specimens taken through inspection of wild-cotton material.⁴ Inspected in Juarez Valley.

BEE CULTURE

The sharp curtailment in the importation of agricultural seeds and beeswax brought about by the war and the necessity of obtaining larger quantities of both, coupled with the fact that sugar rationing has put a premium on honey production, has resulted in the issuance, by the War Production Board and other war agencies working in collaboration with the Department, of various orders designed to promote and encourage beekeeping. More than 50 agricultural crops are dependent on or benefited by pollinating insects, of which the honeybee is the most important.

In a vegetable-seed-producing area in California pollen traps placed on 6 colonies for a 10-day period yielded 33 pounds of pollen. The bees visited approximately 88 million blossoms to obtain this pollen. A plot of alsike clover screened from bees yielded no seed, while 100 unscreened heads yielded 4,437 plump seeds. A single colony in Arizona yielded nearly 10 pounds of alfalfa pollen, which required the visitation of 35 million alfalfa blossoms by pollen-collecting bees.

In the search for superior honey-producing strains of bees, 150 colonies, representing 15 strains, were tested under identical management and environmental conditions. The average production for the different strains ranged from 101 to 260 pounds per colony, and for individual colonies from 0 to 363 pounds. That breeding is a fruitful approach to increased honey production is evident from the wide variation in productivity.

Studies of the resistance of honeybees to American foulbrood continue to show progress. In cooperation with the Agricultural Experiment Stations of Arkansas, Iowa, Texas, Wisconsin, and Wyoming, more than 225 queens of experimental stock were reared and sent to State agencies for testing and observation. Colony resistance to American foulbrood was found to be vested largely in the ability of the worker bees to detect and remove infected larvae from the hive before the causative organism has developed to the spore or infective stage. Tests show that the vegetative stage of *Bacillus larvae* is not infective.

In hybridization and inbreeding studies mating of virgin queens to their sons, which is virtually self-fertilization, shortened drastically the queens' egg-laying periods as well as their spans of life. Inbreeding for five generations by brother-and-sister matings reduced the viability of the brood from 93 percent to 42 percent. Group comparisons of double-hybrid colonies with their three parent lines showed productivity approximately equal to that of the best lines tested.

Contrary to age-old conceptions, some drones were produced by egg-laying worker bees in queenright colonies, and under certain conditions parthenogenetic females were also produced. These findings are of great importance to breeding work and emphasize its complicated nature. They also help to explain many of the difficulties and purported mismatings which bee breeders encounter.

In certain important beekeeping areas in Oregon and Nevada the daily recorded pollen yields in the fall were extremely low—sufficiently low to account for habitually weak colonies in the spring. Colonies that were artificially supplied with extra pollen were able to maintain brood rearing, whereas a decline occurred in colonies on normal stores.

It was possible to promote brood rearing independently of spring weather conditions by providing adequate food in the form of honey and cakes containing soybean flour and pollen. Soybean flour from which the oil had been extracted by the expeller process was far superior for brood rearing to that manufactured by the chemical extraction process.

Uredospores in practically pure form from the leaves of cottonwoods and willows in Arizona, Nevada, and the Sierra Nevadas were collected by bees in substantial quantities when pollen sources were deficient in these areas. Brood rearing was carried on normally when colonies were on a diet of red rust fungus spores and on honeydew from the incense cedar. The large quantity collected and consumed suggests a possible beneficial use of bees in helping destroy fungus diseases.

The nectar from both Pima and Acala cotton contained about 22 percent of sugar, but the quantity per blossom averaged 4 mg. for Acala and 58 mg. for the Pima blossoms. In the field bees were observed neglecting the Acala while they were abundant on the Pima variety. This striking evidence of varietal differences in nectar secretion indicates the possibility of improving honey plants through selection and breeding.

INVESTIGATIONS OF INSECTS AFFECTING MAN AND ANIMALS

MOSQUITO INVESTIGATIONS

During the year military establishments, State and Federal health units, and other agencies were visited by the liaison officer for the purpose of discussing insect problems and demonstrating control devices. This work was concerned mainly with mosquitoes, but also with cockroaches, bedbugs, fleas, flies, lice, chiggers, ticks, and termites. Personnel of the Florida laboratories gave much time to training sanitarians of the United States Public Health Service in the identification, habits, and control of mosquitoes. Practically all the time of an additional entomologist was given to organizing and directing the entomological service for malaria control carried on by the Public Health Service in areas near cantonments in 18 Southern and Eastern States. A series of lectures on insects that affect troops was given to medical officers in training at the Army Medical Center, Washington, D. C.

Sod sampling of 23 marshes in Volusia County, Fla., showed that one large series of samples was sufficient to indicate the relative importance of certain marsh areas as mosquito producers, provided the samples were taken subsequent to mosquito flights.

Experiments to determine the most effective spacing for drainage ditches on marshes indicated that over 90 percent control was obtained by 75-foot spacing, but that control decreased somewhat at greater spacing and was entirely negligible when the ditches were 300 feet apart.

Laboratory tests of 200 new organic compounds were made on larvae of *Culex quinquefasciatus* Say. Of these compounds, p-bromohydrazobenzene and 1-naphthyl methylisothiocyanate were the most toxic, and both were superior to phenothiazine. The most promising indication from these tests was that certain derivatives of naphthalene are outstandingly toxic to mosquito larvae.

In the Pacific Northwest field tests showed that diesel oil containing 4 percent of a certain type of emulsifier is an effective mosquito larvicide when emulsified with water. The use of such emulsifiers will effect material savings of oil. The continued investigation of sleeping sickness in cooperation with the Hooper Foundation for Medical Research in the Yakima Valley, Wash., has resulted in important advances in our knowledge of how this disease may be transmitted to man and horses. Western strains of equine encephalomyelitis and St. Louis encephalitis virus were isolated from *Culex tarsalis* Coq. for the first time in nature.

SAND FLIES AND CLEAR LAKE GNATS

At Fort Pierce, Fla., in cooperation with the St. Lucie Sanitary District, 83 to 90 percent control was obtained through diking and pumping of water from prolific breeding marshes of mangrove and pickleweed. Experiments at Nice, Calif., have shown that two procedures may greatly reduce the gnat populations—the use of light traps with suction fans and the burning of gasoline on the surface of the water where eggs are concentrated. The work on these projects was discontinued on June 30, 1942, because of reduced appropriations.

TICKS AFFECTING MAN

For control of the American dog tick, which serves as a vector for the eastern type of spotted fever, it was found that systematic dipping in derris of all dogs in an area twice each week, repeated for four seasons and combined with meadow mouse control for a single season, was followed by an almost complete absence of this species of tick.

SECRETIONS OF INSECTS

Extract K, a healing agent discovered in the secretions of fly maggots, has been found to stimulate rapid healing in deep-seated purulent wounds and also to promote growth of bone in osteomyelitis, a disease frequently following war injuries. The material is inexpensive and can be made synthetically.

HOUSEHOLD INSECTS

The work on household and storage insects has been largely of a routine and service nature. Observations have been continued on the ability of insects to damage food and food cartons. Studies have been initiated to discover ways to ward off insect attack upon food products, especially dried vegetable, egg, milk, and meat products being prepared now in large quantities as part of the lend-lease program.

SCREWORMS

Two outstanding developments in screwworm research included (1) the formulation of specifications for a process of manufacturing a Turke-red oil which is superior in screwworm and fleecworm smears to those previously obtained in commerce, and (2) the discovery that the moisture content is a vital factor in the efficiency of Turkey-red oil in benzene and diphenylamine mixtures. Most of the ranch-

men in southern Texas are satisfied users of smear MS-62, which was developed last year by the Bureau.

CATTLE GRUBS

Experiments during the past winter have demonstrated that a pressure-sprayer treatment of cattle grubs with rotenone is effective. The method appears promising for treatment of range animals.

FLY SPRAYS

A pyrethrum extract containing 2 percent of total pyrethrins in a light spray oil gave good control of stableflies and horn flies for 24 hours and inhibited feeding and engorgement of these flies for some time after the lethal effect was gone. Derris extracts gave better control than any other spray tested. When sprays containing 10 percent of a derris extract were used, good control was obtained on the second day after spraying, and 80 percent of the horn flies and some of the stableflies were killed on the third day. In view of present restrictions in the use of pyrethrum and rotenone in fly sprays, searches have been made for substitute materials. One new material tested, a thiocyanacetate, has shown excellent results in both laboratory and simulated field tests.

TICKS AFFECTING ANIMALS

Studies on the brown winter tick (*Dermacentor nigrolineatus* (Pack.)) revealed that a wash composed of 7 ounces of derris (5 percent rotenone), 1½ ounces of neutral soap, and water to make a gallon was very effective against this pest, killing even the most resistant adults and providing considerable protection against reinfestation. Several materials have been found effective in destroying all stages of the ear tick (*Ornithodoros megnini* (Dugès)), and tests on duration of protection are under way.

CATTLE LICE

From data gathered on the life history of the short-nosed cattle louse (*Haematopinus eurysternus* (Nitz.)) the most effective interval between dippings has been determined. Field tests made in Texas, in which heavily infested cattle were dipped in cube-wettable sulfur that had been used 21 days previously demonstrated that all motile forms of this louse were killed. This development is of distinct economic importance, since it obviates the rechanging of the vat for the second dipping and effects a saving of half the insecticide. Other tests showed that one application of the cube-wettable sulfur dip killed all forms of the long-nosed cattle louse (*Linognathus vituli* (L.)).

DOG FLIES

In 1941 the program for control of dog flies (*Stomoxys calcitrans* (L.), or stablefly) in Florida used 143,975 gallons of diesel oil as a diluent for creosote oil in the treatment of grass deposits on the shores of inland bays and sounds. Salt water from the bays has since been found to be a satisfactory substitute for the diesel oil. This development eliminates the cost of the oil and reduces the transportation expense considerably.

At Sarasota, Fla., control methods have been developed for dog flies breeding in celery waste. The material is crushed and passed through a vat containing a solution of sodium arsenite. The reduction in volume of waste (65 to 75 percent) resulted in a corresponding reduction in labor and hauling costs.

INSECT IDENTIFICATION

Identifications totaled 57,551 for 18,809 lots, involving approximately 400,000 specimens. Of these identifications 68.5 percent were for activities of the Bureau and other Federal agencies; 13 percent for agricultural colleges, experiment stations, and other offices of the States and insular possessions; 15.1 percent for individuals, private agencies, and pest-control operators in the United States; and 3.4 percent for foreign institutions and agencies, principally in the Western Hemisphere. Of the total identifications, 64.1 percent were definite and complete.

Taxonomic studies conducted in support of insect identification resulted in the completion for publication of 44 manuscripts, totaling 2,134 pages and illustrated with 973 figures. Ninety-seven manuscripts originating outside the Division were reviewed, this work involving the verification or correction of approximately 28,000 scientific names of insects.

About 200 specialist-days were devoted to segregation of valuable type specimens for removal to a safe repository as a precaution against damage from air attacks. The reference collections were reorganized, approximately 60,000 specimens being added. In the interest of advancement of insect classification, 137 loans of insect material to other institutions and scientists were arranged. These arrangements involved the selection of 17,527 specimens.

Assistance in problems of insect identification and classification was given to 81 visiting scientists, including 26 officers of the Sanitary and Medical units of the Army, the Navy, and the Public Health Service, who received instruction in the identification of mosquitoes and other insects directly affecting human health.

FOREIGN PARASITE INTRODUCTION

The work has been restricted during the year because of war conditions, which necessitated closing the Yokohama, Japan, laboratory late in 1941. Investigations are now in progress only in South America. Twenty-six consignments of parasite material from South America and 1 from Japan were imported into continental United States, while 16 were sent from South America to Puerto Rico. Forty-one consignments of parasite material were sent from the receiving station at Hoboken, N. J., to domestic field stations and 4 to foreign countries.

Importations of natural enemies of cotton insects consisted of parasites of the boll weevil, cotton stainer, and bollworm from Peru and of the pink bollworm from Brazil. During the year 3,973 adults of *Microbracon vestitica* Vier. and 1,735 of *Triaspis vestitica* Vier. were imported for direct release against the boll weevil. Importations against the pink bollworm consisted of 121 larvae of *Callie-*

phialtes dimorphus Cush. and 230 adults of *Microbracon* sp. A total of 3,451 adults and puparia of *Acaulona peruviana* Towns, and *Hyalomya chilensis* Macq., parasites of the cotton stainer, were likewise sent to Puerto Rico for testing and colonization, and 1,450 nymphs and adults of *Paratriphleps laeviusculus* Champ. were shipped to Texas for release against the bollworm. A practicable rearing method was developed for *M. vestitica*, utilizing the bean weevil as the host, and 1,767 adults were produced for field release.

Work on natural enemies of cereal and forage insects in South America was confined mainly to parasites of the sugarcane borer. Shipments to Puerto Rico consisted of 18,744 puparia of *Theresia diatraeae* Towns., 1,279 of *Metagonistylum minense* Towns., and 583 adults and cocoons of *Ipobracon* spp.

Among the truck-crop insects the importation from Brazil of *Lydinolydella metallica* Towns., a parasite of bean beetles of the genus *Epilachna*, was continued. A total of 4,696 puparia were forwarded for rearing and direct field release of the adults. Two small consignments of a vegetable weevil parasite were obtained from the same country. Rearing of *Triaspis thoracicus* (Curt.) was completed, and 19,580 adults were forwarded to California for field release against the broadbean weevil.

Shipments of parasites of fruit insects from Japan, prior to the closing of the Yokohama station, consisted of 1,138 larvae of *Pseudaphycus* sp. and 738 of *Anagyrus* sp., both of which parasitize the Comstock mealybug. Emergence of the *Allotropa* sp. material imported early in 1941 was completed, and 28,042 adults were forwarded to Connecticut for field release.

COOPERATION WITH STATE, TERRITORIAL, AND FOREIGN ORGANIZATIONS

In the cooperative work with the Puerto Rico Agricultural Experiment Station, 16 consignments of 2 species of cotton stainer parasites, 5 consignments of 3 species of sugarcane borer parasites, and 7 of a coccinellid predator of scale insects were forwarded to that station from South America. Rearing stock of *Microbracon vestitica* Vier., a possible parasite of the pepper weevil, and of *Triaspis thoracicus* (Curt.) were forwarded to the California Agricultural Experiment Station.

Rearing stocks of parasites and predators were forwarded to foreign countries as follows:

PEST INSECT	PARASITE OF PREDATOR	COUNTRY
Black scale	<i>Scutellista cyanea</i> Motsch.	Bolivia
Boll weevil	<i>Microbracon mellitor</i> Say	Haiti
Cottony-cushion scale	<i>Rodolia cardinalis</i> Muls.	Bolivia
Mealybugs	<i>Cryptolaemus montrouzieri</i> Muls.	Mexico
Pea and bean weevils	<i>Triaspis thoracicus</i> (Curt.)	Australia, Canada
San Jose scale	<i>Prospaltella perniciosi</i> Tower	South Africa via Canada
Soft scale	<i>Coccophagus</i> spp.	Canada
Sugarcane borer	<i>Metagonistylum minense</i> Towns.	Cuba
White peach scale	<i>Prospaltella berlesei</i> (How.)	Bolivia
Woolly apple aphid	<i>Aphelinus mali</i> Hald.	Bolivia

EFFECT OF CHEMICAL-CONTROL PRACTICES ON POPULATIONS OF NATURAL ENEMIES

Insecticidal dusts and even entirely inert dusts frequently caused a high mortality among the adults of scale-insect parasites, and this effect was correlated directly with particle size. Only the very fine dusts caused high mortality. Sulfur and cryolite dusts seriously interfered with biological control of mealybugs on citrus through the colonization of *Cryptolaemus*.

Sulfur sprays and dusts caused a marked reduction in parasitization of the eggs of the white apple leafhopper by *Anagrus*. Spray mixtures of oil and lime-sulfur and of lime-sulfur and lead arsenate had no detrimental effect upon coccinellid enemies of the European red mite on apple.

CONTROL INVESTIGATIONS

TESTING OF INSECTICIDES

Tests on new synthetic and plant materials as insecticides were continued to meet the urgent need for domestically produced substitutes for many insecticides.

Approximately 2,200 tests with 300 synthetic and 11 plant materials were made against leaf-feeding insects. Paraphenyldiazaniline, diazoaminobenzene, and acetone semicarbazone are new materials recommended for field testing. Among the other materials tested, 5 were effective against 3 or more species and 10 others were effective against 1 or 2 species.

To discover a substitute for some or all of the pyrethrum used in household sprays, 1,400 tests with 170 synthetic and 425 plant materials have been made. An extract of prickly ash bark and 1 synthetic material were effective against houseflies when used in a petroleum-oil base. Sesamin, asarinin, and 8 other materials have been found to act as synergists for pyrethrum in fly sprays.

In cooperation with other divisions of this Bureau, the use of liquid dichlorodifluoromethane impregnated with pyrethrins and sesame oil, released in the form of an aerosol, has been developed as an effective weapon against insects, especially adult mosquitoes.

FUMIGATION INVESTIGATIONS

Continued studies on treatments for nursery stock in the area regulated by the Japanese beetle quarantine resulted in the development and approval of two new methyl bromide fumigation schedules, the extension of all approved schedules to cover packaged perennials, and the approval of two schedules for the fumigation of produce in tight van bodies.

Improvements in vacuum fumigation for the white-fringed beetle have made it possible to raise the limit of the diameter of soil balls from 11 to 16 inches, and have modified existing schedules so that treatments can be applied at lower temperatures, and the risk of plant injury thus reduced. Improvements in atmospheric fumigation have raised the limits of ball size 25 percent. Approximately 120,000 plants were fumigated commercially by the two methods during the past season.

Experimental fumigation of sweetpotato slips and vine cuttings with methyl bromide for sweetpotato weevil control was concluded, and about 1,500,000 plants were fumigated commercially at a cost for the fumigant of about 2 cents for the number of plants required for 1 acre. In the treatment of sweetpotatoes in transit 70 carloads were fumigated. Forty-eight varieties of sweetpotatoes in lots of 1 bushel or more were treated without injury.

A laboratory was established at St. Louis, Mo., in cooperation with the Division of Fruit Insect Investigations and the Missouri Department of Agriculture, to study methods of fumigating nursery stock for control of *Parlatoria chinensis* (Marl.), a scale insect of foreign origin.

Schedules were also developed for fumigating bare-rooted nursery stock in winter storage for the destruction of root infestations of the woolly apple aphid. Schedules for fumigating plant materials infested with the European corn borer were also completed.

Storage fumigation of seed potatoes for control of the potato tuber moth was applied commercially on the Eastern Shore of Virginia, with a resultant saving of about \$5,000 to the farmers in that area.

In cooperation with the Division of Insects Affecting Man and Animals, fumigants, schedules, and methods were developed for use by the armed forces in the destruction of body lice in clothing.

In the development of treatments of imported plant products, studies were directed principally to insects infesting imported potted orchids. Progress has been made on methyl bromide fumigation schedules, and data on the reaction of nearly 4,000 plants, representing 43 genera, have been obtained.

INSECT PHYSIOLOGY AND TOXICOLOGY

In accordance with wartime needs, research programs in insect physiology have been revised to give increased emphasis to problems of toxic action of insecticides and the toxicology and physiology of insects and insect products. Studies were made on possible insecticidal action of antibodies, mode of action of sodium arsenite, physiological factors influencing the resistance of insects to sodium fluoride and pyrethrum, and histochemistry of and fat inclusions in insect hemocytes. Evidence suggests that insecticidal action of sodium arsenite is greatly influenced by its degree of dissociation. Particles of certain insecticides (e. g., lead arsenate) that enter the insect body cavity may be taken up by protective phagocytes. Interference with the functions of the phagocytes may affect the resistance of the insect to pyrethrum and sodium fluoride, as well as to sodium arsenite and nicotine.

In cooperation with the Division of Insects Affecting Man and Animals a preparation was developed to relieve itching caused by bites of chiggers and certain other insects.

Laboratory fumigations against the bedbug indicate methyl bromide, acrylonitrile, and several other chemicals to be effective. Some of these chemicals were also toxic to flour beetles. Methyl bromide has been used successfully to control bedbugs in Army barracks bags.

INSECTICIDE INVESTIGATIONS

Results of research to develop new insecticides and fungicides and to improve methods of applying them were made available to the public in the form of 67 scientific articles. In addition, 10 patents were granted members of the Division.

The fall of Singapore cut off half of this country's supply of rotenone-bearing roots, of which about 9 million pounds was imported in 1941. To encourage the collecting and growing of rotenone in South and Central America, the Division has analyzed numerous samples of plant material for rotenone content. Chemical investigation of devil's-shoestrings, certain strains of which contain 5 percent of rotenone, has been continued. Anabasine, a potent alkaloid that is closely related to nicotine but is four or five times as toxic to certain aphids, is found in the tree tobacco, and samples of this plant growing in the Southwestern States have been examined. Pyrethrum flowers, which now come almost exclusively from East Africa, have been studied chemically. A more exact and quicker method of determining the content of active principles in these flowers has been developed, and their structures have been determined.

Synergists which boost the action of the pyrethrins and thus in effect augment the supply of pyrethrum flowers were studied. Sesamin from sesame oil and asarinin from the southern prickly ash were found effective for this purpose. Certain synthetics structurally related to these plant principles are being investigated.

Since the United States must import all its rotenone and pyrethrum, it is highly desirable to find equally effective compounds which can be synthesized in this country. The patents granted members of this Division describe many materials of this class, including semicarbazides, the semicarbazones of certain aldehydes, morpholine salts of dithiocarbamic acid, amino and chloro acetanilides, and xanthone. Xanthone, which has shown excellent results in the control of codling moths in the Pacific Northwest, is now being manufactured commercially. Against mosquito larvae it is more toxic than rotenone, being effective at a concentration of 1 part per million parts of water. Since troops must be protected against malaria and yellow fever, all materials of high larvicidal value assume great importance.

One of the most significant developments, in which this and other Divisions of the Bureau cooperated, has been the distribution of non-volatile insecticides in the form of aerosols. A highly effective aerosol is made by dissolving pyrethrum extract in dichlorodifluoromethane (Freon), which at ordinary temperature is a gas but can be condensed to a liquid under about 100 pounds' pressure. Opening a valve in the cylinder holding the solution forces the contents into the air. The dichlorodifluoromethane immediately volatilizes, leaving a suspension of colloidal particles of pyrethrins which are extraordinarily deadly to many dangerous insects. The Army, the Navy, and the Public Health Service are adopting this method of killing mosquitoes under certain conditions. Because dichlorodifluoromethane has no fire hazard and is not poisonous or irritating, this method of applying insecticides has been used successfully in airplanes while in flight.

The war has greatly curtailed the supply of materials that enter into the manufacture of many of our most potent insecticides, fungicides, and grain fumigants, and a large part of the work of the Division has been concerned with finding substitutes.

The Division has continued to serve many of the other divisions of the Bureau by analyzing samples and advising on chemical phases of entomological work. In this connection more than 1,700 samples were examined.

TRANSIT INSPECTION

More than 1,390,000 shipments of quarantined materials moving interstate via mail, express, and rail, water, and motor freight were inspected to determine compliance with Federal domestic plant quarantines. In addition nearly 1,700,000 waybills covering rail-freight movement were examined for the same purpose. There were 2,842 apparent violations of 8 of the 9 current Federal domestic plant quarantines, which were intercepted or reported for investigation. These shipments were moving to points in 48 States, the District of Columbia, Canada, and Puerto Rico. In addition, 42 violations of the regulations governing the movement of plants into the District of Columbia and 1,052 apparent violations of State nursery-inspection requirements and State plant quarantines, including those pertaining to phony peach, peach mosaic, and sweetpotato weevil, were reported.

Inspections were conducted by 38 inspectors at 17 transportation centers. Cooperation was received from States affected and from transportation agencies. Studies of the interstate movement of quarantined materials via motortruck were initiated to determine methods for more effective inspection.

TERMINAL INSPECTION OF MAIL SHIPMENTS

The States maintaining terminal inspection of mail shipments of plants and plant products under the procedure carried out in cooperation with the Post Office Department, which provides for turning back or disinfecting shipments if found infected, are Arizona, California, Florida, Idaho, Louisiana, Minnesota, Mississippi, Montana, Oklahoma, Oregon, Utah, and Washington. The District of Columbia, Hawaii, and Puerto Rico also maintain this procedure. The States that have availed themselves of the provisions of the terminal-inspection procedure for the enforcement of their plant quarantines are Arizona, Arkansas, California, Florida, Minnesota, Mississippi, Montana, and Oregon.

CONVICTIONS AND PENALTIES IMPOSED FOR VIOLATIONS OF THE PLANT QUARANTINE ACT

For the second year in succession it has been found unnecessary to institute legal proceedings for violation of any of the numerous quarantines issued under the Plant Quarantine Act. Minor violations by smugglers of Mexican plants and plant products along the southern border, which are more or less constant from year to year, are disposed of directly by customs officials. Fines aggregating \$364.10 were im-

posed by customs officials against 352 persons caught attempting to smuggle in prohibited plants and plant products from Mexico. For similar offenses last year a total of \$301.60 was assessed against 283 persons.

FOREIGN PLANT QUARANTINES

MARITIME PORT INSPECTION

The war has greatly affected the arrival of ships and the nature of their cargoes. Vessels frequently arrive in convoys, and almost always without advance notice, creating peaks of work for plant-quarantine inspectors without adequate forewarning. The practice of observing radio silence until the ships are in port caused much stand-by time, and the berthing of ships at less frequented subports and at out-of-the-way piers necessitated increased travel time. Despite a decrease of 26 percent from 1941 in the number of ship arrivals, more time was required to complete the inspections, as the average over-all time per vessel rose from 2 hours and 10 minutes in 1941 to 4 hours and 14 minutes in 1942. Changes in the ports of origin of the shipments and the reduction of coastwise movement of ships from foreign ports resulted in a reduction of only 22 percent in the number of inspections made, as compared with that in 1941. Ninety-two percent of all arriving ships were inspected in 1942, as compared with 87 percent in 1941.

Cargo space was devoted more and more to material of war as the year progressed and, consequently, less to plant propagating material. The number of containers of imported nursery stock was only about 14 percent of the number in 1941, but the quantity of seeds imported was five and one-half times as great. Importations of fruits and vegetables were roughly comparable to those in 1941 except for a marked decrease in banana imports. Increases in importations of cotton lint and other cotton products amounted to about 6 percent of the bales imported. Fibers and cereals arrived in quantities much larger than in 1941, except for a commodity for exportation.

Inspections both of ships and their cargoes were complicated by current conditions. For example, warships of other United Nations putting into United States ports for repair, and cargo vessels for repair and arming, created new problems in safeguarding against the entry of pests that might be in stores or cargoes containing plant materials prohibited entry into this country. Cargoes restricted to, and normally entering at, northern ports, such as foreign cotton lint, which is subject to vacuum fumigation upon arrival, were in some instances forced to be discharged at southern ports in the Cotton Belt, creating problems of safeguarding against possible introduction of the pink bollworm to the cotton areas of the South Atlantic and Gulf States.

The record of ship inspections appears in table 6. This table does not include ships engaged only in Great Lakes trade.

TABLE 6.—*Number of ships arriving, inspected, and bearing prohibited plant material, fiscal year 1942*

Origin	Arriving	Inspected	With prohibited material
	<i>Number</i>	<i>Number</i>	<i>Number</i>
Foreign ports, direct.....	15,991	15,415	4,958
Foreign ports, via United States ports.....	4,470	3,539	667
Foreign ports, via Hawaii.....	121	121	59
Foreign ports, via Puerto Rico.....	60	60	40
Hawaii, direct.....	933	933	225
Hawaii, via United States continental ports.....	148	113	16
Puerto Rico, direct.....	225	224	32
Puerto Rico, via United States continental ports.....	97	81	3
United States ports, via Panama Canal.....	889	601	22
Total.....	22,934	21,087	6,022

Importations of plants and plant products were as follows: Fruits and vegetables, 7,626,161 containers, 40,126,506 bunches of bananas, 11,026,586 pounds, and 57 units; nursery stock and seeds, 15,138 containers, 417,549 pounds, and 188,757 units; cotton lint, bagging, and cotton products, 841,053 bales, 1,179,540 other containers, and 36,685,114 pounds; fibers and cereals, 4,117,259 bushels, 37,700 containers, 102,858 pounds, and 21,150 units. In addition, 635 lots of plant material were inspected at Canadian border ports, where no plant-quarantine inspectors are stationed, through the cooperation of the customs officers and the Canadian Department of Agriculture.

At the Mexican border ports there were several thousand importations of fruits and vegetables in such small quantities that no entries were required by customs, and no plant-quarantine record of them was kept; hence they are not included in the figures given above. All these small importations were inspected before being released, and their handling represented a large amount of work, especially at the larger ports.

DISINFECTION

The following plant material was treated under the supervision of inspectors and collaborators of this Bureau: 596,060 bales of broom-corn, cotton lint, linters, cotton wrappers, etc.; 383,072 pounds of cottonseed meal and cake; 5,464 containers of chestnuts, cipollini, miscellaneous plants and bulbs, and pigeonpeas; 10,851 samples of cotton lint, linters, etc.; 269,777 plants, cuttings, bulbs, roots, and other plant propagating units; and 1,590 pounds of seeds. The bales fumigated represent a 25-percent increase over the number fumigated in 1941.

AIRPLANE INSPECTION

The 8,653 airplanes from foreign countries which were inspected upon arrival at 21 ports of entry represented 1,707 more than the number inspected in 1941; 1,338 of these were found to carry prohibited plant material, much of which came from places where it is known to be the host of injurious pests. The 16 percent carrying prohibited material, as compared with 11 percent in 1941, as well as the 25-percent increase in the number of planes inspected, is evidence

of the increasing possibilities of the introduction of injurious insect pests by this rapid means of transportation.

Seven hundred and fifty-one interceptions of insects and plant diseases were made in connection with airplane inspection. Most of these pests were found in plant material carried in baggage, cargo, mail, and stores, but some mosquitoes and other stowaways which might menace public health were included. Plant-disease interceptions included the destructive banana leaf spot (*Cercospora musae* Zimm.) on banana leaves used as packing for a gardenia, dahlia rust (*Coleosporium dahliae* Arth.) on dahlia, and sweet orange scab (*Elsinoe australis* Bit. and Jenk.) on tangerine, which are not known to occur in this country, as well as a number of our serious diseases. Most of the intercepted insects were of minor importance or represented pests already known to be established in this country, but included were such pests as the Mexican fruitfly, the West Indian fruitfly, the pink bollworm, the mango weevil, the aleyrodid *Tetraleurodes fici* Q. and B., as well as some undetermined insects which appeared to be new to science and which might be potentially destructive pests.

FOREIGN PARCEL-POST INSPECTION

During the year 83,361 foreign parcel-post packages were inspected. Of these 388 were refused entry in whole or in part because of their content of prohibited plant material, 6,137 were diverted to another port for disposition, and 2,678 were released under permit. The volume of parcel-post matter inspected was 20 percent less than in 1941, primarily because of current world conditions.

MEXICAN BORDER SERVICE

A total of 54,802 freight cars from Mexico were inspected during the year, which represents an increase of 11,079, or 25 percent, over the number inspected during 1941. To safeguard against pest risk it was necessary to fumigate 7,969 freight cars as a condition of entry into the United States. In addition, 3,728 Pullman and passenger coaches entered and were inspected. A total of 4,847,429 other vehicles and 841,810 pieces of baggage were examined through cooperation with the customs officials. These figures represent increases of 52 and 20 percent, respectively, over those for 1941.

INSPECTION IN PUERTO RICO AND HAWAII

The inspector in charge of the enforcement of foreign plant quarantines as they affect the entry of foreign plant material into Puerto Rico was assigned an assistant from the mainland early in the year owing to the developments connected with defense activities. Insular inspectors also acted as collaborators in this work, as well as in the enforcement of Quarantine 58, which covers the movement of fruits and vegetables from Puerto Rico to the mainland. War-time conditions have had a profound effect upon the plant-quarantine work in the island. For example, 2,018 airplanes were inspected upon arrival as compared with 876 in 1941. Under the liberalized restrictions of Quarantine 58, which was revised in 1941, only 216 certificates were issued for the movement of fresh fruits and vege-

tables to the mainland in 4,955 containers, as compared with 2,670 certificates in 1940, the last full year before the revision. A part of this reduction can also be attributed to the currently increased demands for food in the island.

With the cooperation of post-office officials, parcel-post packages mailed at the 4 principal post offices on the island to destinations on the mainland were inspected before dispatch. This arrangement made it possible to intercept much prohibited plant material before it left the island and also reduced considerably the number of Puerto Rican mail packages requiring inspection on arrival on the mainland. A total of 8,170 parcel-post packages were examined in Puerto Rico, and the 46 found to contain prohibited plant material, which were returned to the senders, represent a slight decrease from the previous year in spite of the 86-percent increase in the number inspected.

The crisis of December 7, 1941, brought abrupt changes in the work in Hawaii. Prior to that date there was indication of a record year as the tempo of national-defense activities brought increased movement, and the Federal inspection staff of seven was augmented by four inspectors. Under war conditions there is less movement of fruits and vegetables to the mainland, and the emphasis is placed on cooperation with the Army and the Navy to provide ships, airplanes, baggage, and mail with the maximum of plant-quarantine safeguards possible under the circumstances, and without impeding the war effort. This change in emphasis necessitated considerable revision in procedures, and four of the personnel were released to other activities.

During the year 1,210 shipments consisting of 40,540 bunches of bananas, 22,056 crates of pineapples, 54,590 coconuts, and 286,105 pounds of other approved fruits and vegetables were inspected and certified for movement to the mainland. Of the last items, 79,701 pounds of papayas were given the approved heat-sterilization treatment under close supervision, prior to certification.

During the year 645,477 parcel-post packages destined for the mainland were handled; of these 202,576 were opened and inspected, and 58 were found to contain prohibited material. During the latter half of the year plant-quarantine inspection and censorship activities were coordinated in cooperation with postal censor authorities.

Airplane, express, and baggage inspection continued along the lines discussed in the 1941 report. As would be expected, there were important increases in the activities associated with movements of airplanes and of ship and airplane passengers.

INSPECTION OF SPECIAL-PERMIT AND DEPARTMENTAL PLANT MATERIAL

The enforcement of the regulations governing the movement of plant material into and out of the District of Columbia required the inspection of 562 shipments of incoming domestic material (consisting of 71,546 plants, cuttings, bulbs, etc., and 632 lots of seeds) and 1,189 shipments of outgoing domestic material (consisting of 190,430 plants, cuttings, bulbs, etc., and 4,304 lots of seeds). For the elimination of pests in these shipments 20,783 plants, 2,281 lots of seeds, and in addition 264 parcels containing plant material not for propagation were given some form of treatment. In addition to the

material listed, 17,874 containers of plant material were examined at the post office, express office, and freight stations. Fifty-nine truckloads containing 193,929 plants consigned to retail merchants in the District of Columbia were checked on arrival for proper certification.

INSPECTION OF PLANT-INTRODUCTION AND PROPAGATING GARDENS

Plant material which is being propagated at plant-introduction and propagating gardens maintained by the Bureau of Plant Industry is inspected regularly for the presence of plant pests. Such material distributed from the gardens at Coconut Grove, Fla., and Mandan, N. Dak., was inspected by State officials cooperating with this Bureau. The inspections at Chico, Calif., were handled jointly by an inspector of this Bureau and an entomologist from the California Department of Agriculture. Material distributed from the District of Columbia, Maryland, and Savannah, Ga., stations was examined by inspectors of the Bureau. The following were examined prior to distribution from these stations during 1942: 379,624 plants, 11,390 bud sticks and cuttings, 8,513 roots and tubers, and 12,903 shipments of seeds.

INTERCEPTIONS OF PROHIBITED AND RESTRICTED PLANTS AND PLANT PRODUCTS

The numbers of interceptions of prohibited and restricted plant material for 1942 were as follows: In baggage, 46,422 prohibited, 6,982 restricted; in cargo, 1,078 prohibited, 448 restricted; in mail, 275 prohibited, 162 restricted; in quarters, 5,135 prohibited, 521 restricted; in stores, 3,048 prohibited, 346 restricted; total, 55,958 prohibited, 8,459 restricted. In addition, there were 478 interceptions of prohibited and restricted plant material in baggage by customs at Mexican border ports where no plant-quarantine inspectors are stationed, and 1,890 similar interceptions by customs at Canadian border ports which are without plant-quarantine inspectors.

PESTS INTERCEPTED

During the inspection of foreign plants and plant products, and of such products received on the mainland from Hawaii and Puerto Rico, inspectors and collaborators of the Bureau collected insects belonging to 1,100 recognized species and others distributed among 721 genera and families, as well as fungi, bacteria, and nematodes belonging to 286 recognized species and large numbers of other pathogens that could be referred to genus, family, or general group only. Many of these interceptions were of important plant pests, others were of scientific interest, and a number were of undescribed species.

The combined total of 60,268 interceptions of insects and diseases made during the year were taken as follows (figures refer to number of interceptions): In material offered for entry for consumption, 34,840 insects, 17,196 diseases; in material offered for entry for propagation, 3,074 insects, 1,273 diseases; in material not offered for entry, such as in-transit shipments and materials in ships' stores, quarters, etc., 1,724 insects, 2,161 diseases; total, 39,638 insects, 20,630 diseases. In addition, inspectors stationed in Puerto Rico made 44 interceptions each of insects and diseases during their field and packing-house inspection of fruits and vegetables for shipment to the mainland.

CERTIFICATION FOR EXPORT

During the year 3,995 certificates covering 1,351,463 containers of plants and plant products were issued to meet the sanitary requirements of foreign countries. Export certificates were issued at 32 ports covering 59 commodities which were exported to 57 foreign countries.

The arrangements made in 1941 continue to be available to the armed forces in meeting the sanitary requirements of the countries concerned in connection with the movement of supplies to leased defense bases outside the limits of the United States.